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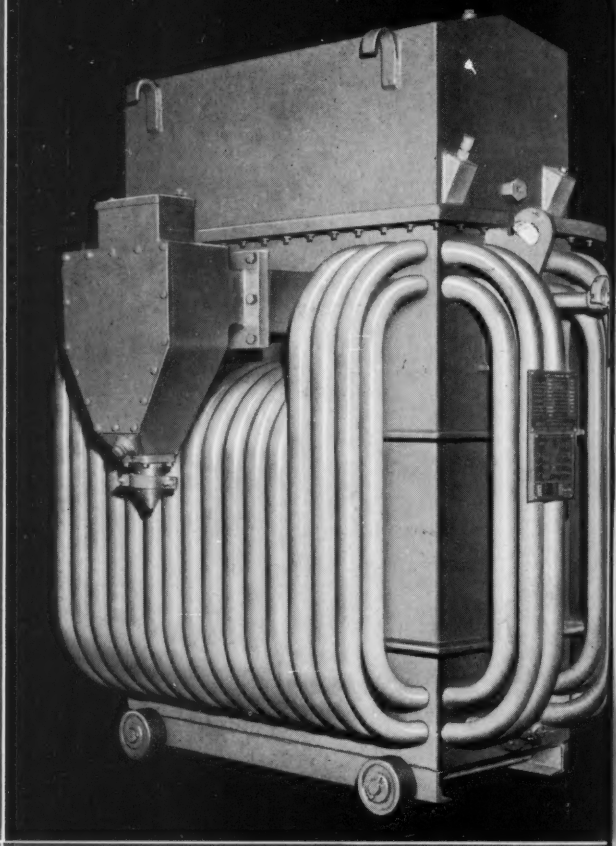

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tropical climatic conditions, manufactured
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Finished in Hadrian Red Oxide Primer,
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Right:-
Teleflex
importan
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A. C.
General

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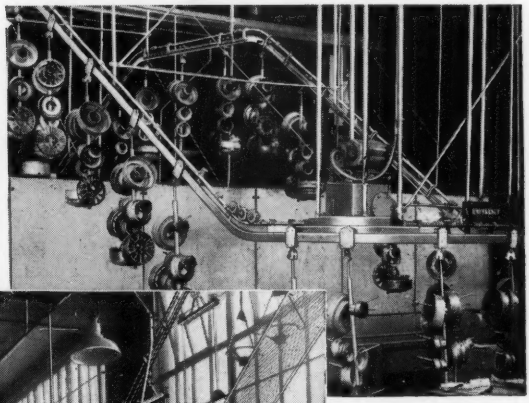
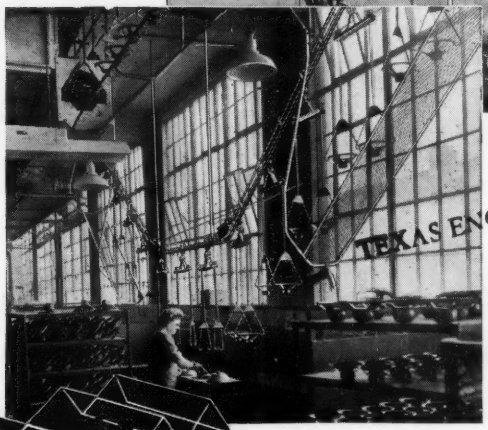
THE LIGHT CONVEYOR FOR HEAVY LOADS



Right:-
Teleflex conveyors form an important aspect of the production system of Messrs. A. C. Delco—Division of General Motors.



TEXAS ENGINEERS LIBRARY
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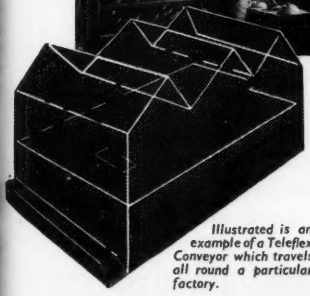
Left:-
Teleflex conveyors are important links in the production lines at the works of the Plessey Co. Ltd., Ilford.



Illustrated is an example of a Teleflex Conveyor which travels all round a particular factory.

It is almost certain that some stage of production or packaging of your production can be economised and speeded up by the installation of one or other of the Teleflex Conveyor Systems. Either Cable or Chain type conveyors can be supplied soon after receipt of your order.
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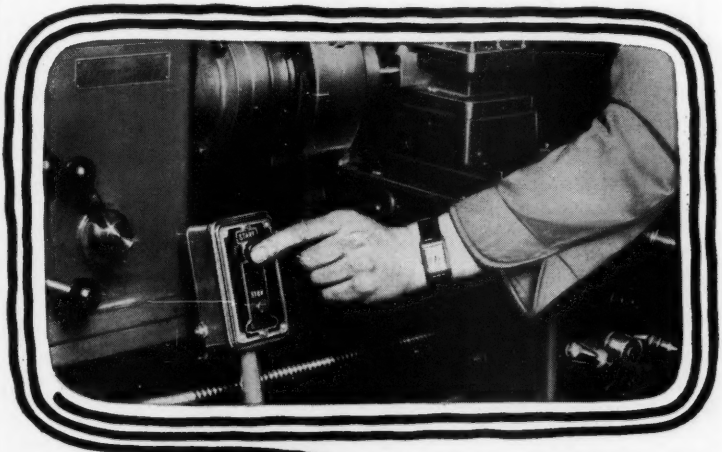

The Finger on the Button

And the eye on the job. The machine under the control of a button, the man free to use all his skill.

The machine is a lathe, set up for boring. Accurate work, careful work, but the push button can make it fast work. The hand on the button is symbolic. By freeing skill from unnecessary distractions, electric control speeds up production, raises productivity—and lowers costs. Push button control is ONLY ONE OF THE AIDS TO HIGHER PRODUCTIVITY THAT ELECTRICITY CAN BRING YOU.

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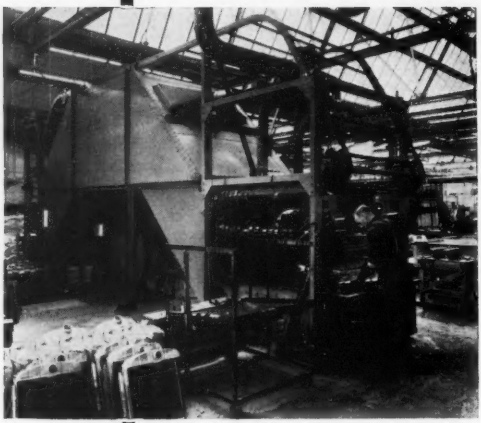

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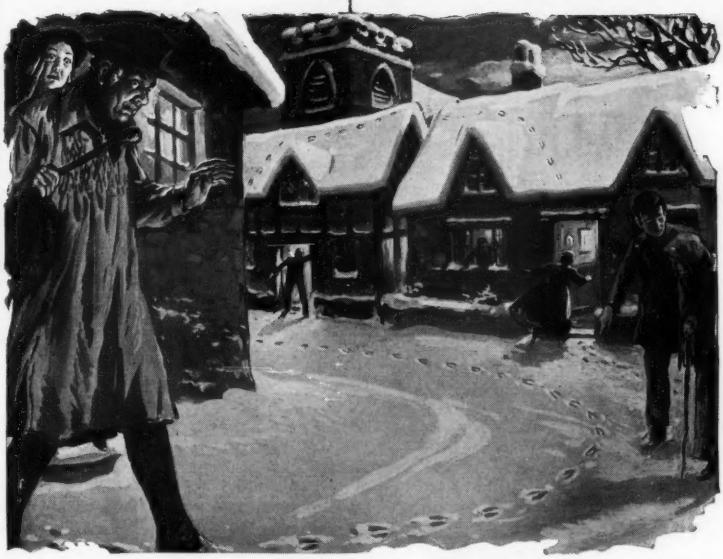

...THE DEVIL CAME TO DEVON

The snow fell heavily in South West Devon during February, 1855. Rising early for their work, the population of an area of over 100 square miles were horrified to see vast numbers of extraordinary footprints everywhere, which could not be identified as belonging to any known animal or bird. These footprints proceeded in straight lines over roof-tops, walls, in woods, towns, farmyards, taking no account of obstacles. They appeared to be made by cloven hooves, and where the snow was thin *the earth was laid bare, as though scorched.*

Superstitious people quickly decided that they must have been made by the Evil-one himself, and few would venture forth after nightfall for some time. Careful measurements were taken and placed before learned men of the time—but in spite of many theories they could not be identified, to clear up the mystery.

With the melting of the snows these sinister footsteps vanished without trace . . . . .

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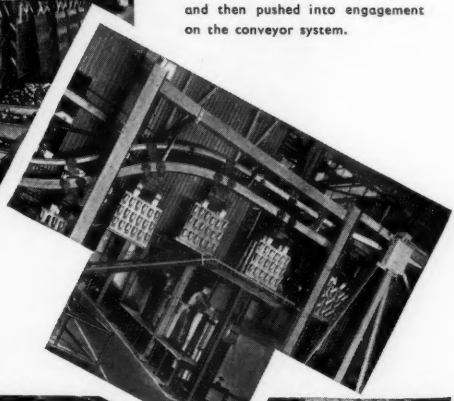
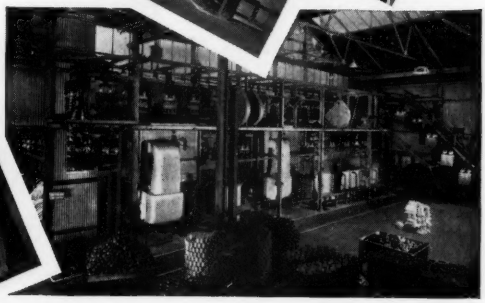
MODERN TREATMENT OF STEEL PIPE FITTINGS

Photograph left:
Trolleys with empty carrier plates are automatically delivered to the free track for loading with fittings and then pushed into engagement on the conveyor system.



Photographs right:
Views of loaded carrier plates progressing towards and through the process section of the conveyor, where they are automatically degreased, rinsed, phosphate coated, dried, varnished and stoved.

Photograph below:
Illustrates continuous electrostatic paint spraying on to fittings prior to entering oil-fired, air circulated, stoving oven.



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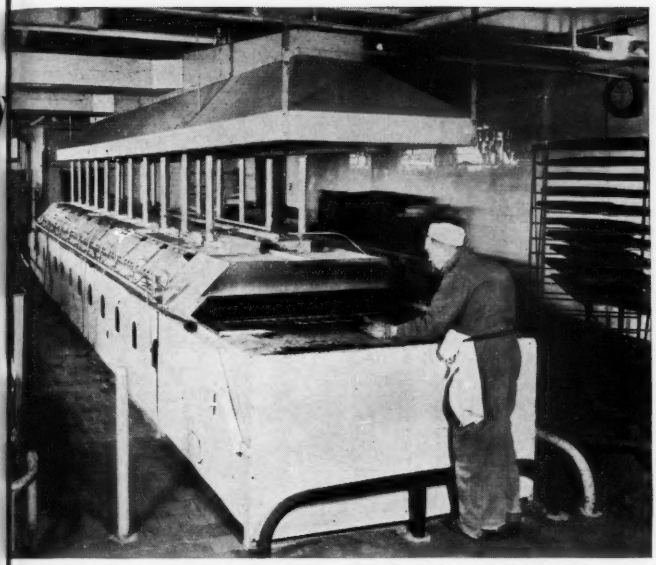

Photograph by courtesy of J. Lyons & Co. Ltd., Cadby Hall, London.

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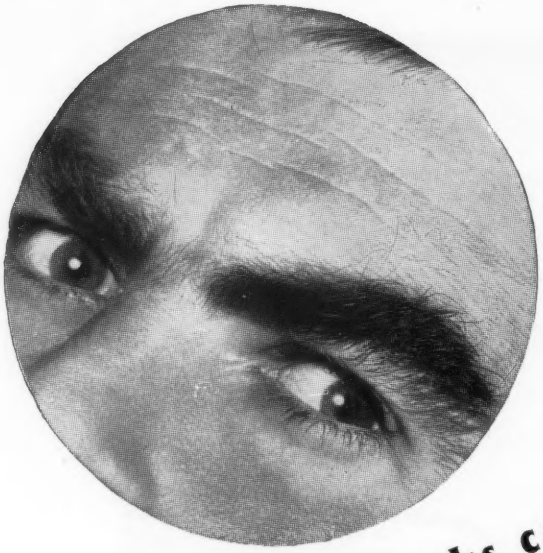

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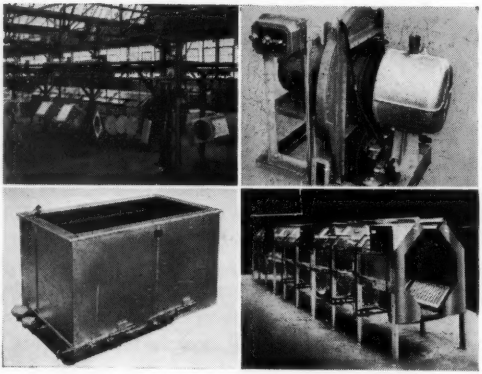

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Aerostyle Water Wash Booth with conveyor. Photo by courtesy of the Ministry of Supply

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4	Cold rinse and spray		37
5	Acid dip		37
6	Cold rinse and spray		37
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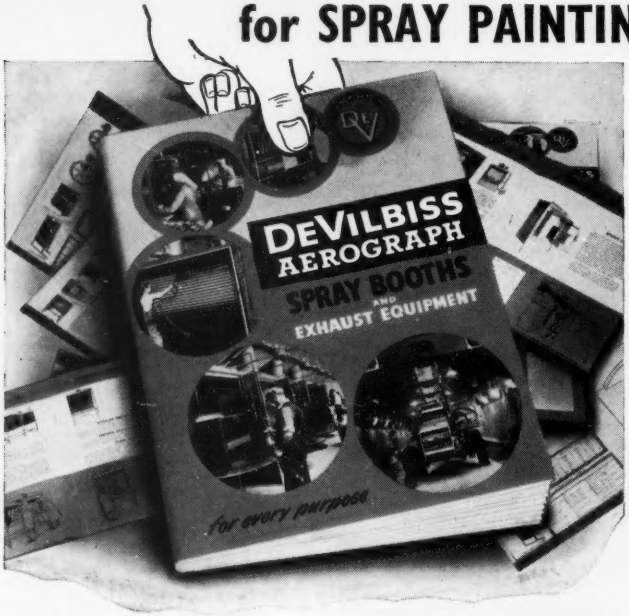

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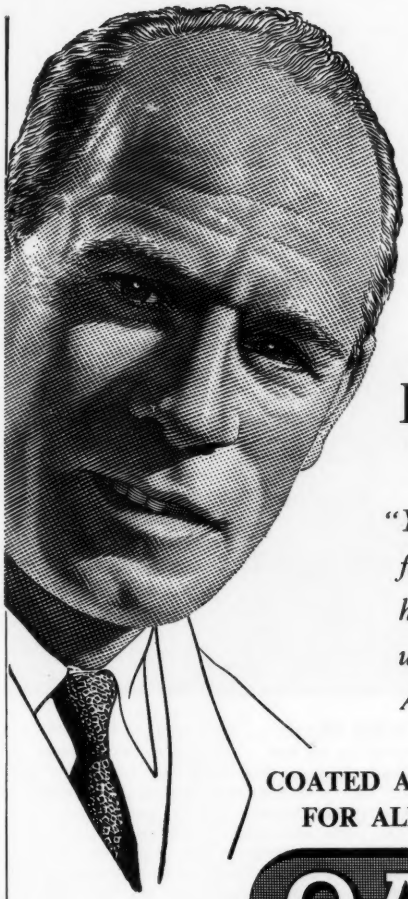

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JULY 1954

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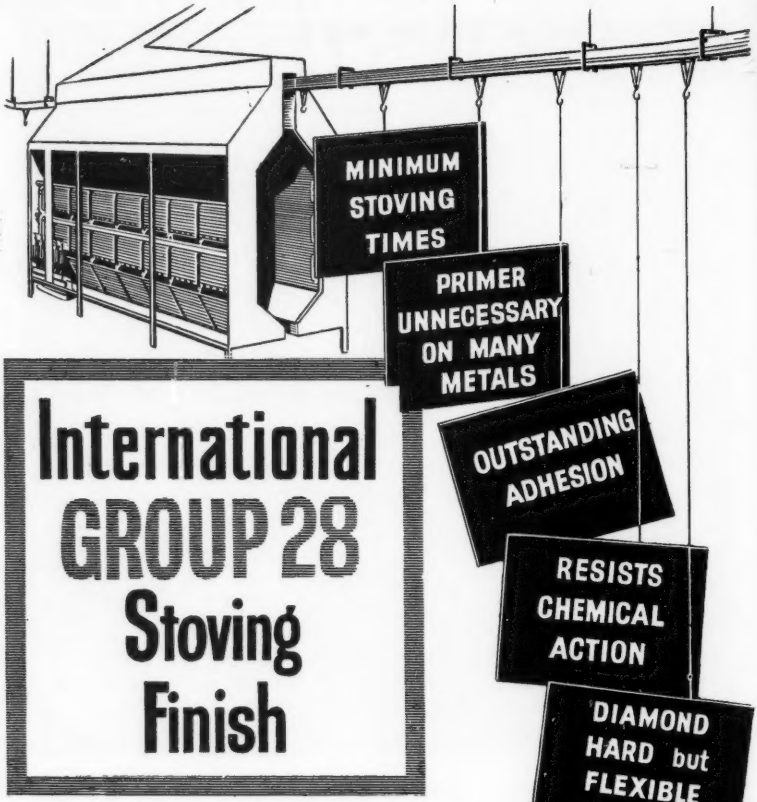

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Industrial Finishing

VOL. 6 JULY, 1954 NO. 73

Home Decorating and the Professional

FOR quite a while there has been some concern among the professional decorators in the paint trade due largely to the influx of activity from the amateur. It was, therefore, interesting to read the comment made by the Chairman of Blundell, Spence & Co. Ltd., when he opened the new works at Bankside, Hull, concerned with making the new plastic paint, Pammastic.

Undoubtedly the idea of doing the job at home emanated from America. Mr. Calvert was quite convinced that the need for any real professional skill in the case of ordinary home decoration had been eliminated. Undoubtedly roller coating and modern paints had helped him considerably, but at this spot he thought the amateur had reached the end of his real hope. He considered that improved paints had helped the amateur together with good sale of inexpensive brushes, rollers and paint sprays which would work from a vacuum cleaner. He made in his address, an important point when he said that the future of the professional decorator is concerned with specialisation. He rightly suggested that as far as some jobs are concerned they were beyond the amateur. He quoted painting a block of flats, a ship, an office block and so on. Again he pointed out that it was false economy to cut down the period between renovation of a building too much.

He said, "We must educate industrial and commercial concerns to a more intelligent approach to paint."

He was after all right in his final estimation that the threat of the amateur decorator was not more serious than it had been in other trades and professions. He concluded that the future of the professional rested not in competition for jobs which the amateur could do, but by specialisation in those particular tasks which the amateur could never attain.

Modern Jobbing Finishing Shop Equipment

A Visit to the Works of C.N.C. Enamellers Ltd., at Hanworth Trading Estate, Feltham, Middlesex

THE type and scope of the equipment installed in a plant carrying out a wide range of processes on a jobbing basis is necessarily a matter for some considerable thought, both on the score of the use that will be made of it and the suitability of equipment readily available for the various processes. As it is never possible to forecast what will be coming into the shop from day to day, it is essential to provide plant and equipment which is adaptable and versatile.

C.N.C. Enamellers Ltd. is a firm which has grown considerably in recent years, and now handles a large volume of plating work in addition to cellulose, synthetic and stoved enamelling work. Our visit, a month or two ago, was at the joint invitation of their managing director, Mr. W. G. F. Thornley, and Mr. C. A. G. Stevens, manager of the Industrial Plant Division of Neil and Spencer Ltd, Leatherhead, Surrey, who have recently completed the installation of some interesting hot cleaning tanks and a radiant drying unit based on the Spencer industrial unit.

The hot cleaning tanks, two in number, are illustrated in Fig. 1. As will be seen, they are of the immersed, tubular burner type, and each tank is provided with two 4 in. tube injectors of the Aeromatic type. Together they pass approximately 400 c. ft. of gas per hour. At the time of our visit these tanks were in use and it was seen that the two burners together quickly brought the tank up to temperature and, thereafter, the working temperature was easily maintained by one burner alone.

Mr. Thornley informed us that, prior to the installation of these tanks, the gas bills for heating cleaning tanks of the orthodox pattern had been quite prohibitive and the time lag for cleaning solutions to come up to temperature had been a frequent cause of

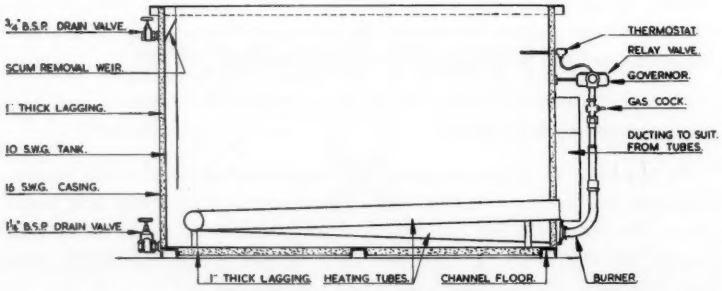

Fig. 1. Drawing showing arrangement of the hot cleaning tanks.

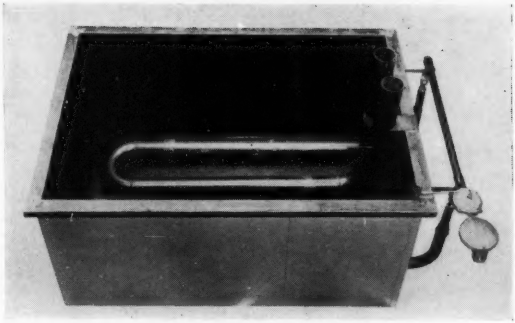

Fig. 2. Showing the immersed pattern twin-tube Aeromatic burner in the hot cleaning tank

delay and irritation. The thick lagging, plus thermostatic control, of course, contribute to economical operation.

C.N.C. Enamellers do a considerable range of plating, and the tanks and solutions in regular use include Effco bright zinc, Effco bright nickel, Effcolene cleaner, dull nickel, chrome, stannate tin, cadmium, brass, silver and copper. There are normally four vats working on copper, three on zinc, three on nickel, two on bright nickel and one each on silver and tin. In addition, a battery of barrel plating machines is kept busy on a similar range of small barrel plating work. We noticed that, out of six medium-sized barrel machines at least five were Cruickshank machines, and Mr. Thornley informed us that he was normally able to keep these barrels in 100 per cent. use on regular jobbing work.

Passing over to the second section of the plant, the enamelling shops, an impressive feature was the conveyorised spraying and drying equipment. Housed in a clean and airy room, this consists of a standard Teleflex conveyor, a set of spray booths and a versatile radiant drying unit. The general layout is in the form of a square circuit from booths, through flash-off area, on to drying unit and cooling space prior to unloading. Figs. 3 and 4 show the conveyors and other equipment.

The radiant drying unit is of particular interest, as it was designed to meet the varying requirements of a jobbing shop. Fig. 4 shows the general structure. The ends are arranged to open or close, to adjust the length of the cooling area. The panels, eighteen in number, are of the standard type used by Neil and Spencer in industrial applications.

This panel has been designed especially for heat processing work, and its assembly into an oven construction is simplicity itself, yet it is robust enough to carry its own weight. It can be fitted either vertically, canted 45° forward or 45° backward. It is, therefore, possible to build the units into a plant of almost any desired shape, including a tunnel which is to all intents and purposes circular in cross section.

The unit is a completely tooled job, so that every part is interchangeable, and therefore replaceable. Its construction is such that the maximum amount of strength and rigidity is obtained with the minimum amount of weight. A great deal of attention has been paid to the problem of maintenance, a point too often neglected with industrial equipment. Every part can be removed easily through the heater back panel, which is fabricated in aluminium, so that although the back is exposed, the heat loss is low.

On the inner side of the front panel is a baffle plate to ensure even distribution of heat over the surface, and against the inner side of the back panel a John Mansville rigid asbestos block is inserted with an attachment to keep it in position, and handles for easy removal. The block contributes substantially to the prevention of heat loss and is fitted at an angle to give a tapered combustion space which keeps

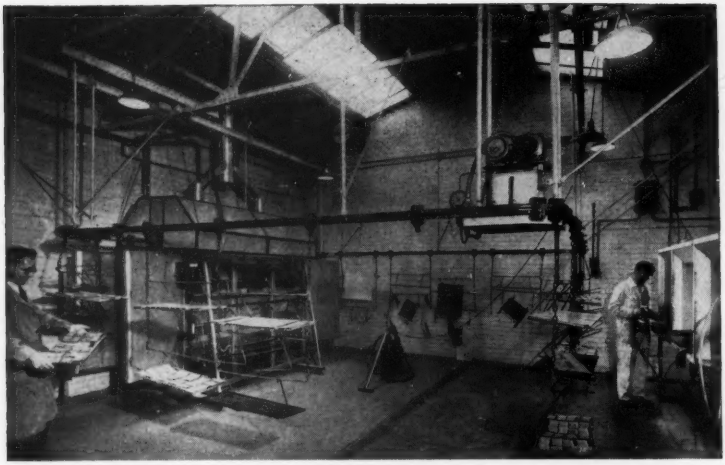

Fig. 3. General view of conveyorised finishing shop at C.N.C. Enamellers Ltd.

the heat against the front panel. There are twenty gas jets running along the base of the interior of the unit; they are of the Bray flat flame type, size 00. These are easily replaced when necessary, although they should operate satisfactorily for some months.

The main gas supply is tapped to give an individual supply to each panel, and each of these has its own cock for lighting, which can be done by means of a torch or by a pilot light. The pressure of each set of

(*Continued at foot of page* 884)

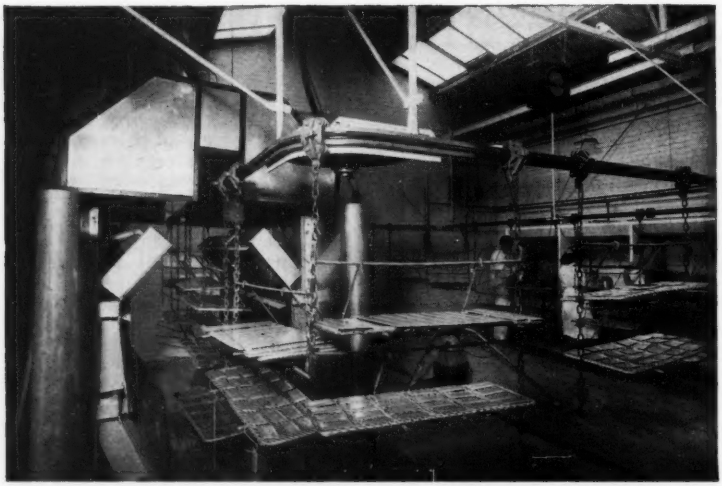

Fig. 4. Showing the general constitution of the radiant drying unit.

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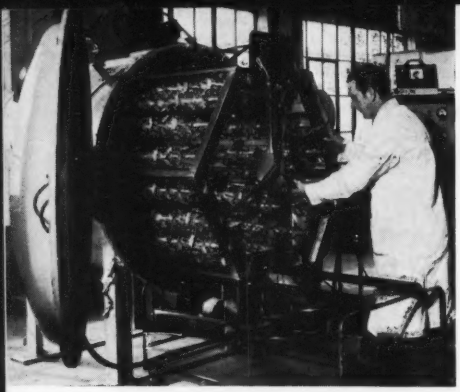


Left: Photograph shows how the articles to be metallised are loaded and placed in the vacuum chamber

PROGRESS IN VACUUM METALLISING

THE Enfield plant of Dome Ltd., has taken this company into a new field and one which they consider will be of great importance in the finishing industry—vacuum metallising on a jobbing basis. Their factory is currently handling such items as artificial jewellery, perfume bottle tops, headlamp reflectors, cabinet handles, furniture fittings and car badges.

The technique of coating plastics, metals, glass and so on with thin films of metals by vacuum deposition has previously been used for many years, mainly for scientific products. The application of the process to more utilitarian and industrial purposes is comparatively recent. Dome claim that the hard-wearing, corrosion-resistant finish which they have evolved puts vacuum metallising on equal footing to electroplating in the same wide industrial fields. Because the process is essentially a batch process, it lends itself well to jobbing, and is sufficiently adaptable to undertake large quantities of articles ranging from a few dozen to thousands of gross.

The process consists of applying a preliminary lacquer base to the articles by dipping or spraying. They are then placed in a vacuum chamber from which the air is extracted to approximately one millionth of an atmosphere. At this stage the coating takes place. This is achieved by "firing off" aluminium from hot tungsten wire while the articles are rotated to ensure an even coating and good finish. A final protective coat of clean lacquer is applied and if a colour is desired, a dye is then used. Any colour finish may thus be obtained without losing the high sheen imparted by the metal coating. Special means have been devised for handling articles of all types, including very small ones. The finish is non-tarnishing and needs no polishing. The fact that it is a dry process makes it suitable for finishing plastics and glass. Its high brilliance derives from using aluminium which gives a reflective capacity of 90 per cent.

Industrial Art Bursaries Competition, 1954.—The Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2, are once again offering prizes amounting to £2,500, in this year's Industrial Art Bursaries Competition. The prizes take the form of travelling bursaries, usually of £150 each, and are open to students who intend to take up industrial designing as a career. The closing date for entries is 11th October.

Change of Address.—As from 4th June, 1954, all communications for the Bureau of Abstracts and the Society of Chemical Industry Abstracts should be sent to: Society of Chemical Industry Abstracts, Room 147, North Block, Thames House, Millbank, London, S.W.1.

(*Continued from page* 882)

burners is regulated before the unit is sent out, but can be adjusted when necessary; it is possible to control spheres of different temperature on the same bank of panels.

Each unit has an emitting area of 2 sq. ft., an average surface temperature of 650° F. rising to 800° F. maximum. The output radiation is 4,500 B.Th.U. per hour and the total gas consumption for the unit is in the region of 500 c. ft. per hour.

The units are so arranged on the framing that they can be turned in or out as seen in our illustration, to adapt the shape of the tunnel to the work in hand.

In addition to the new equipment described there is another radiant conveyorised plant of an earlier type, which is used for certain special jobs, and a range of equipment for smaller jobs.

New equipment planned for the future, Mr. Thornley told us, includes dipping and drying equipment to cope with the increasing amount of tubular and wire work the firm are being asked to finish.

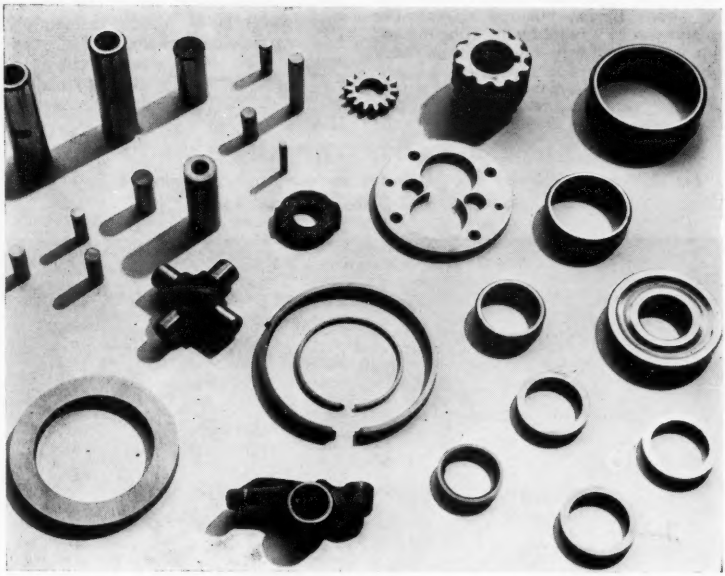


Fig. 1. Collection of typical pieces ground upon two opposing surfaces

SURFACE GRINDING

PIECES of the varied types shown by the photograph Fig. 1, possess two characteristics in common, that is, they all have to be accurately ground upon two flat opposing surfaces, and they are all components required by the respective industries in such large quantities as to make some form of automatic handling and grinding a departure which would be likely to pay handsome dividends by increasing the production and lowering its cost.

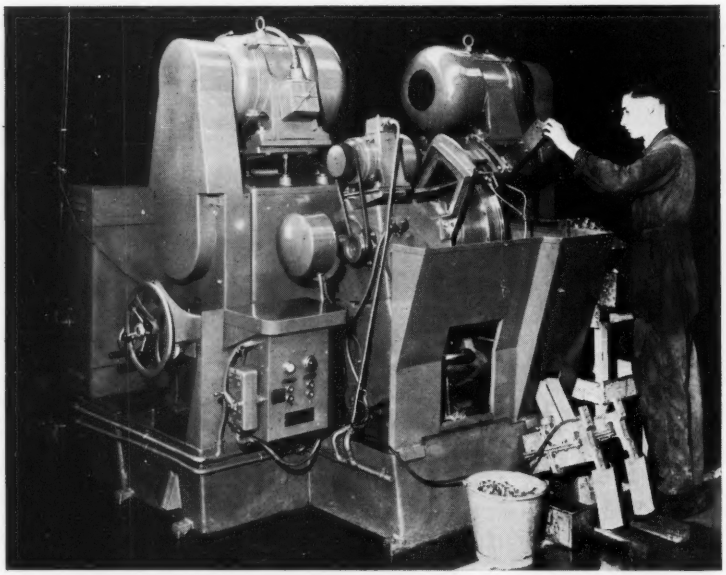
The use of a machine mounting two grinding wheels enables the two surfaces to be ground in a single operation, and if these two wheels are *vertically* mounted this arrangement confers the important advantage that many classes of work can be fed by gravity means of simple and inexpensive chutes. Some such method of automatic gravity feed would be applicable in about 90 per cent. of the cases illustrated by the photograph, and some estimate of the production obtainable by this means can be made from the fact that rings 1¼ in. dia. by ½ in. thick of the type shown in the bottom right-hand corner can be ground on the two faces in one operation with a stock removal of ·010 in. each side to final limits of plus-minus ·0005 in. at the rate of 2,800 rings per hour. Other types of piece, such as connecting rods, valve rockers, spring ends, and universal joint crosses for the motor-car industry would require a more expensive type of rotating fixture, which, by reason of the time required for loading, would be somewhat slower than the more spectacular productions obtained with gravity feed. Another convenient method of feed, especially for large pieces, is to pass the work through the grinding zone carried on a conveyor belt.

A normal Duplex grinder of the type described would be one having grinding wheels 24 in. to 30 in. dia., and the grinding capacity of such a machine would be approximately some 120 sq. in. for each of the opposing surfaces of the piece. The thickness of the work, represented

by the distance apart of the two grinding wheels, is adjustable usually from zero to about 12 in., but rod or tube-like pieces can be ground by the same method on a machine with a suitably extended bed.

The foregoing remarks are prompted by the recent appearance of a new horizontal-spindle Duplex grinder by the firm of Arthur Scrivener Ltd., Tyburn Road, Birmingham, shown by Fig. 2. Each wheel is 24 in. dia., running at 1,140 r.p.m., and powered by a 20 h.p. motor. The floor space occupied is 6 ft. 0 in. by 5 ft. 6 in., and the net weight of the machine illustrated is 5¾ tons.

Fig. 2, below: Scrivener No. 24 Duplex surface grinder. Powered by a 20 h.p. motor, the wheels rotate at 1,140 r.p.m.



ALUMINIUM LABORATORIES BANBURY EXTENSION

ALUMINIUM LABORATORIES LTD., the research, engineering and geological exploration unit of Aluminium Ltd., announce the completion of the new extensions to their research laboratories at Banbury, Oxon. The new facilities, construction of which was begun in 1951, have cost over £300,000; they add a further 44,000 sq. ft. to the floor area of the older building, making a total area of 65,000 sq. ft.

The new premises provide a completely integrated modern laboratory fully equipped for chemical, metallurgical, physical and engineering research. The many facilities available include a laboratory designed for the testing of large prototype aluminium structures for ships, bridges and other purposes. Another laboratory is devoted to research into the use of aluminium for canning. This includes prototype equipment for drawing and lacquering aluminium containers and for testing their behaviour when packed with different products. A model plant for the production of aluminium paste used as a pigment for paint is available for development studies; another large experimental shop houses equipment for service and development work on welding and other joining processes suitable for aluminium and its alloys.

Progress in Synthetic Resins

(SPECIALLY CONTRIBUTED)

AMONGST the most remarkable of the modern synthetic resins are the condensation products of epichlorhydrin and diphenylolpropane, marketed in this country under the trade name *Epikote Resins** and in America as *Epon Resins**. As surface coatings these resins have exceptional toughness, adhesion and resistance to chemical attack, as well as being essentially a flexible coating. Examples of their current applications are summarised later in this article in Table 1. The use of Epikote Resins is by no means confined to surface coatings. Various grades are being employed as adhesives, in the preparation of laminates, as stabilisers in the plastics industry, in cast forms, and so on. Within the scope of this article, however, only the four grades associated with surface coatings will be examined.

These are all solid materials, available in a range of molecular weights. In general, Epikote resins of low molecular weight are used in combination with other synthetic resins to produce low temperature stoving finishes. They are used when the greatest degree of compatibility with and solubility in other resins and oils is necessary. In this respect they can act as modifiers for other resin coatings to improve adhesion to metal, flexibility and resistance to chemical attack. The higher molecular weight Epikote Resins show improved resistance to chemical attack. In unmodified form they find application in industrial stoving primers and finishes, resistant coatings for chemical and food containers, drums, etc., and for wire enamels. Middle grades, esterified, can be used for stoving finishes and air-drying primers and finishes and wood varnishes.

One of the most attractive features of Epikote-base finishes is their remarkable adhesion to both wood and metal surfaces. No priming coat is necessary, nor is chemical pre-treatment or the use of an etching primer necessary to secure good adhesion to aluminium and light alloys. Tests on metal blocks bonded together with various Epikote-base combinations have realised shear strength values (of the bonding film) in excess of 5,000 pounds per sq. in. Typical figures include 3,600 pounds per sq. in. with copper and 500 pounds per sq. in. with solder. The bond with ferrous metals is of an equally high order. Modification of existing stoving alkyds or other normal resin finishes with a low melting point Epikote resin enhances the adhesive properties of the surface coating accordingly.

General properties of the four main grades of Epikote resins of primary interest are summarised in Table 2. Epikote 1001 is compatible with a majority of alkyd resins, pure phenolic resins, urea formaldehyde and sulphonamide resins, chlorinated biphenyl, linseed oil, butyl acetyl ricinoleate and, to a more limited extent, cellulose nitrate compounds, to give a short list of surface coating materials to which Epikote resin may be added as a modifier, Epikote 1001 being the usual "modifier" in such cases. If esterified with a fatty acid, however, the Epikote resin may itself be used as a base for an air-drying brush or spray type finish.

Actually all of the Epikote resins can be esterified quite readily, the type of fatty acid used and the optimum temperature of the operation being dependant on the grade of resin. The degree of esterification obtained can

**Shell Chemicals Ltd., and Shell Chemical Corporation, respectively.*

TABLE I. TYPICAL APPLICATIONS

Application	*Formulation.* *Epikote resin.*	*Other.*	*Coating Characteristics*
Food can coatings.	Unmodified	Amino or Phenolic resin	Resistant to fruit acids, excellent adhesion, flexibility permits reworking coated sheets.
	Esterified	Amino resin	
Coatings for washing machines, refrigerators and other domestic appliances.	Unmodified	Amino resin or Amine cured	Good adhesion, durability, etc. Resistant to detergents, acids, etc.
	Esterified	Amino resin	
Furniture finishes.	Unmodified	Amino cured	High durability, resistant to alcohol, etc. Protection with one coat.
	Esterified	—	
Spar varnishes.	Esterified	—	Good protection, high durability, etc.
Coatings for concrete structures.	Unmodified	Amino cured	Good durability, resistant to alkali, primer or finishing coats.
Linings for drums, pipes, tanks, etc.	Unmodified	Phenolic or Amino resin	Good adhesion, good flexibility. High resistance to chemical attack.
		Amino cured	
Flexible coatings.	Unmodified	Phenolic or Amino resin	Coatings for collapsible tubes, etc., excellent adhesion.
		Amino cured	
Protective coatings.	Unmodified	Phenolic or Amino resin	High protection for chemical plant, etc.
		Amino cured	
Metal primers.	Unmodified	Amino cured	Excellent adhesion, wear resistance and colour stability. Primers or finishing coats.
	Esterified	Amino resin	
Metal finishes.	Unmodified	Amino cured	Excellent adhesion, e.g., light alloy and zinc die castings.
	Esterified	Amino resin	

TABLE II. COATING GRADES OF EPIKOTE RESINS*

	Epikote 1001	*Epikote* 1004	*Epikote* 1007	*Epikote* 1009
Form	Solid	Solid	Solid	Solid
Melting point, °C.	64-76	95-103	127-133	145-155
Specific gravity	1·204	1·154	1·146	1·189
Refractive index	1·60	1·60	1·60	1·60
Viscosity (Gardner-Holdt scale)	C-G	R-T	Y-Z1	Z_2-Z_5
Equivalent weight†	130	175	190	200

*Shell Chemicals Ltd.

†Grams of resin to esterify one mol of monobasic acid.

TABLE III. TYPICAL FORMULATIONS

Epikote grade	*Form*	*Surface Coatings*
1001	Unmodified	Modifier for other synthetic resin stoving finishes. Cold cure and low temperature stoved amine—cured coatings.
	Esterified	Air-drying brush application finishes.
1004	Unmodified	Alkali-resistant coatings.
	Esterified	Air-drying spray application finishes, stoving finishes and spar varnishes, etc.
1007	Unmodified	Stoving finishes, protective coatings, wire enamels.
	Esterified	Stoving primers and finishes.
1009	Unmodified	Stoving finishes, protective coatings, wire enamels, etc.

be varied throughout a wide range, which factor can be used to control the durability of the resulting product. Solvents required for the esterified resins are then of the highly aromatic type.

In general, esterified Epikote 1001 resins are confined to the production of air-drying finishes, using a suitable drying oil fatty acid, Esterified Epikote 1004 is also prepared for air-drying finishes, also stoving primers and finishes and clear varnishes. Esterified Epikote 1007 is used for stoving primers and finishes. Epikote 1009 is not normally employed in esterified form.

In the case of air-drying finishes the esterified Epikote contains about 60 per cent. solids, on average and constitutes some 40 or 50 per cent. of the overall mix (per cent. by weight) depending on the pigment used. Solvents (e.g., White Spirit) approximate to some 35 to 45 per cent. of the total. The most satisfactory drier is generally cobalt in the proportion of about ·04 to ·05 per cent., usually added in the form of cobalt naphenate. Total solids content of a typical white air-drying enamel would be 50 per cent., the pigment in this case being rutile.

Stoving enamels are usually prepared from esterified Epikote 1004 and 1007 resins in conjunction with other synthetic resins, e.g., melamine formaldehyde, urea formaldehyde and phenyl formaldehyde resins. Melamine resins have limited compatibility but are satisfactory within certain proportions and materially improve the hardness of a pure Epikote resin ester (stoved) film. Phenolic resins give maximum chemical resistance whilst the urea-formaldehyde resins are essentially non-critical as regards the proportions which will result in a satisfactory cure.

Stoving temperatures vary with the exact formulation employed. In the case of melamine-Epikote resin esters, stoving temperature may be as low as 200°-250°F., with a minimum curing time of 30 minutes, achieved by the addition of a minute proportion of a satisfactory drier. Without the drier, stoving temperature required would be about 300°F. With phenol- and urea-formaldehyde formulations, a minimum stoving temperature of 400°F. is normally employed, with a drying time of 5 to 20 minutes, depending on the degree of pigmentation. Clear films require minimum drying time and elevated stoving temperatures for best results.

Flexibility of the resulting stoved finishes has been demonstrated by making 180 degree bends of small radius on coated metal strips without rupture or failure of the coating. The coating is also extremely shock-resistant in that it will withstand sharp blows without flaking off—a combination again of flexibility and an extremely strong bond with the parent surface on which it is applied.

Chemical resistance is exemplified by inertness to attack by most common acids and alkalis, including soaps and detergents. Adequate protection to a surface which would normally be attacked by such agents is usually given by a single coat, applied without a primer, about the only pre-treatment necessary being to clean the surface prior to painting or spraying. In this sphere Epikote resin formulations have a particular appeal for protective coatings for chemical plant and containers, coatings for cans and linings for drums. The high adhesion of the film allows the material to be worked after coating, if necessary, to simplify fabrication of the final product.

Hardness of the coating means that it possesses a higher abrasion resistance than many other standard coatings so that it becomes particularly favourable for use under arduous service conditions, such as panels or even flooring, subject to regular scuffing. As a furniture finish, of course, resistance to chemical attack is an added virtue. Typical data are summarised in tabular form for convenience of reference.

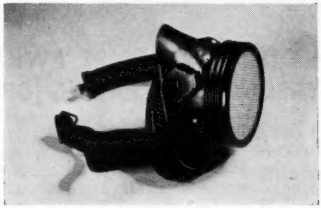
Pigments.—We have received a brochure announcing the publication of a 224 page book "Pigments" by J. S. Remington and Dr, W. Francis dealing with the pigments used in the paint, enamel, cellulose, lacquer and synthetic resin finishes found on the market today, their manufacture and properties. The price of the book is 20s., and it is published by Leonard Hill Ltd., Stratford House, Eden Street, London, N.W.1.

RECENT DEVELOPMENTS

MATERIALS : PROCESSES : EQUIPMENT

IMPROVED "PULSAFE" RESPIRATOR

THE new model of "Pulsafe" respirator incorporates a redesigned rubber face-piece with a flexible wire spring which, in conjunction with headband adjustment, ensures an air-tight seal with light pressure against the face. The screw front on this model is now made of aluminium instead of plastic. The metal parts are anodised, and press stud fastening of the headband has been adopted in place of wire clips.



The "Pulsafe" respirator

The respirator is available in three variations—No. 2M with a thin felt filter being suitable for protection against paint spraying and dry dust. It is 4 oz. in weight, and price is unchanged for new model. The respirator is manufactured by Safety Products Ltd., St. George's House, 44 Hatton Garden, E.C.1.

A NEW COLOURLESS PROTECTIVE PAINT FOR METAL SURFACES

MANY methods employed for the corrosion protection of metals have various disadvantages. For instance, metal which is greased, quickly loses its lustre and is soon covered with a layer of dust; furthermore, saponification of the grease film occurs due to changes in temperature and humidity.

Under the name "Pantarol" a synthetic-resin-cellulose-metal salt combination has been developed by a West German firm, which, it is claimed, will, on application, keep practically all metals bright and untarnished for many years.

Pantarol paint is highly resistant to moisture, hence its use renders the greasing of metal surfaces unnecessary. The protective paint can be applied in a few minutes by brush, spraying or dipping. The paint remains fully effective up to temperatures of 120° and has been used with success on many different alloys as well as on galvanized and other protective coatings.

Pantarol-protected surfaces can be cleaned of dust and dirt by a thorough washing-down and under normal conditions the surfaces so protected remain corrosion-free for five to twenty years.

Pantarol-protected surfaces, when exposed to abnormal conditions such as atmospheres of high humidity, or acid mists, smoke gases and steam, remain corrosion-free for approximately three to five years. The latter remarks apply particularly to bright pipe work, vessels and instruments in breweries, textile factories and chemical plants.

If Pantarol-treated surfaces are exposed to normal weather, a period of three to twenty-four months will elapse before weathering becomes evident. Before treatment with Pantarol, surfaces must be de-greased using the usual materials. Before spraying or immersion of the work occurs, Pantarol must be thinned. At normal workshop temperatures the drying time amounts to 15 min. (A drying temperature exceeding 50° C. is unsuitable.)

With cast and relatively smooth surfaces Pantarol concentrated is used, with polished or ground surfaces an addition of from 30 to 100 per cent. Pantarol dilution is used. A litre of Pantarol is sufficient to treat from ten to twelve m^2 surface.

The State Material Testing Station in Berlin/Dahl has subjected Pantarol to the most rigorous tests lasting two years. For instance, by hanging up Pantarol-treated specimens in battery rooms and in the exhaust flues of furnaces. The tests indicated that specimens treated

with Pantarol remain bright, while unprotected metal surfaces exposed to the same conditions were heavily corroded. The very good protective qualities of Pantarol were also confirmed by subjecting Pantarol-treated copper and steel test specimens to saline and other atmospheres for a period of three months.

PROTECTIVE CREAM

FOLLOWING investigations into the high incidence of occupational dermatitis among workers in contact with synthetic glues and resins, the Research Department of Rozalex Ltd., 10 Norfolk Street, Manchester, has developed a new barrier cream which, used in conjunction with normal protective measures, minimises the risk of skin irritation in handling these substances. This new preparation was first shown at the B.I.F. on the Company's stand, together with the full range of their barrier creams similarly evolved during twenty-six years of continuous research. Progress has been such that protection is now available against the effects of almost every known industrial irritant. The Rozalex Dispenser—an appliance developed to issue controlled and uncontaminated supplies of creams was also on show.

"CATHODIC PROTECTION" REDUCES MARINE CORROSION

A NOVEL and relatively inexpensive anti-corrosion device, successfully tested in the tanker Auris over the past year, has been developed, it is announced, by F. A. Hughes and Co. Ltd., of London, in collaboration with Shell. Long period trials under practical conditions have shown that it reduces the rate of corrosion by some 80 per cent. By this device, known as the "cathodic protection" technique, an electrical current is applied to the metal of sufficient intensity to smother the inherent differences in electrical potential on the metal's surface. In oil tankers this is achieved by magnesium anodes of special design and composition which are permanently fitted in the cargo tanks and come into operation automatically as soon as these are filled with sea water ballast.

Some idea of the saving that may be achieved can be gauged from the fact that maintenance costs on an average size tanker, which costs about £1,000,000, can amount to £250,000 in less than 10 years. The Auris tests have been applied to the cargo tanks, that part of an oil tanker most susceptible to corrosion, but the device, it is claimed, is applicable in different form, to hulls in all steel-built ships. Tests are now being carried out on the hull of the Shell Quest, a converted merchant vessel that is serving as a depot ship aiding the underwater oil search in the Persian Gulf.

MODIFICATION EASES AWKWARD METAL SPRAYING JOBS

RECENTLY, Metallisation, Barclays Bank Chambers, Dudley, Worcs., had the job of spraying an aircraft engine component inside and out with aluminium. Two machines were made for the treatment of these components, one with a bent nozzle to cope with awkward corners. The wire was fed through this bent nozzle by a variable-speed motor. By making such a machine wire feed was consistent and the deposit

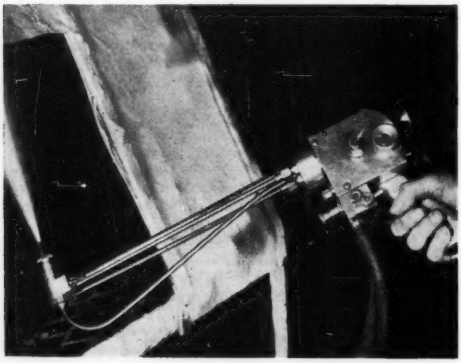
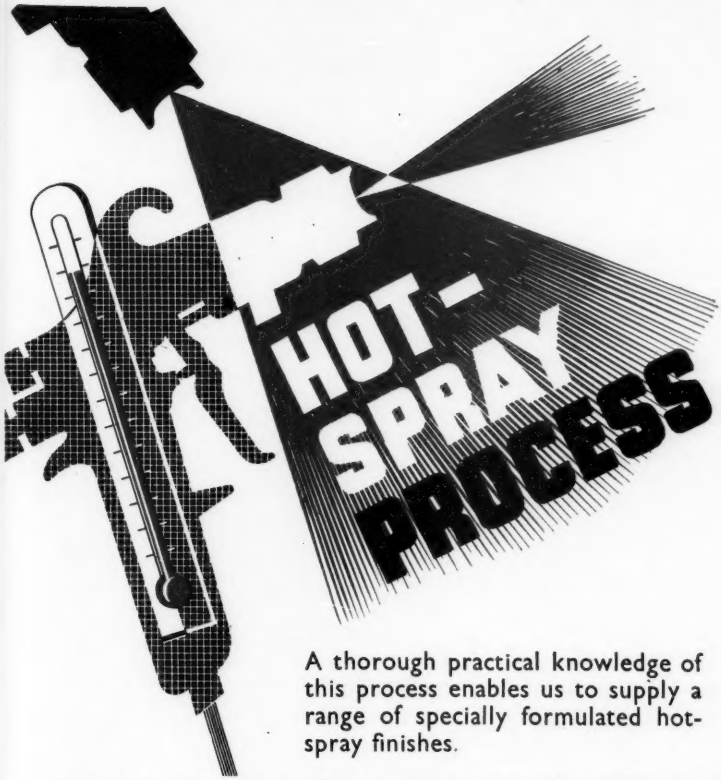


Illustration shows how the bent nozzle modification helps in dealing with awkward corners. Deposit can be exactly controlled



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It may be that you could use this process with advantage and if you would like to know more about its possibilities, we will gladly send a senior member of our Technical Staff for consultation and arrange a demonstration at our works.

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over the component could be exactly controlled.

Because of the success of this particular machine, the nozzle was fitted and found to be useful on the hand pistol. Despite the fact that it is smaller than the standard one the deposit has not suffered in consequence.

INDUSTRIAL COMPRESSOR UNIT

DESIGNED to achieve the maximum efficient working life with the minimum attention and maintenance, a ruggedly-constructed, pedestal-mounted, compressor unit, the 200 SAS, is now in quantity production by The Hymatic Engineering Co. Ltd., of Redditch, Worcestershire. With a displacement of 5·25 c.f.m. at 750 r.p.m. and a working pressure of 100-150 p.s.i., the 200 SAS may be incorporated as initial equipment or as an optional extra on tractors, special vehicles, machine tools and powered plant of all kinds for such duties as spray painting, the operation of pneumatic tools, jigs and fixtures and many other compressed air applications. When necessary the unit may also be operated at 1,000 r.p.m. to give a displacement of 7 c.f.m. against a working pressure of 100 p.s.i.

The single 200 c.c. capacity, high duty cast-iron cylinder, bore 2·67 in. and stroke 2·16 in., is of the single-stage type, heavily finned so that in conjunction with the finned cast aluminium cylinder head and the generous inlet and outlet ports, a consistently low delivery temperature is maintained.

Weighing 38 lb. complete, the Hymatic 200 SAS absorbs about 1 h.p. at 750 r.p.m.

PORTABLE INDUSTRIAL VACUUM CLEANER

GREATER suction per rated horse-power from aerodynamically-designed impellers and a long working life are two of the chief advantages claimed for the new Filtavac portable industrial vacuum cleaner, Model RM22.

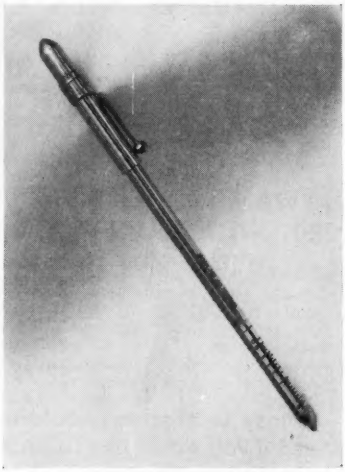
The cleaner will reach up to 30 ft. without any auxiliary equipment, and a special working head will clean dirt from the top of beams while operating from ground level. Two machines can be coupled, doubling the suction power, and uncoupled very quickly. Metal receiver bin can be fitted.

Driven by a ¾ h.p. motor, the machine is 34 in. in length, 15½ in. wide, 37½ in. high and manufactured by Filtavac Ltd., 64a Kensington Church Street, W.8.

PENCIL THICKNESS GAUGE

DESIGNED as a simple and inexpensive gauge for measuring the thickness of non-magnetic coatings such as paints or platings on ferrous bases, the Tinsley Pencil Thickness gauge is calibrated within a range of 0·0002 to 0·015 in., or 0 to 400 microns, and works at an accuracy of ±15 per cent.

It consists of a specially-light magnet attached to a spring contained within a six-inch-long pencil-like tube. It is non-destructive and can be applied to surface of any shape or curvature with the sole limitation that it must be vertical and perpendicular to the surface.



The Tinsley Thickness Gauge: its length is approximately 6 in.

To take a measurement the magnet is placed on the testing surface and the body of the gauge is drawn away, thus extending the spring. The spring extension, the amount of which is observed on the scale, is proportional to the force required to free the magnet from attraction to the surface. A layer of the non-magnetic material, such as paint, between the magnet and the ferrous base, decreases this force and hence the spring extension will be a measurement of the thickness of the layer.

The gauge is manufactured by Tinsley (Industrial Instruments) Ltd., North Circular Road, London, N.W.10.

ALUMINIUM PASTE

JOHNSON AND BLOY LTD. have recently announced an addition to "Metana" range of aluminium pastes for all types of finish. The new quality "Special 75" has the high metal content of 75 per cent. and has been developed for the specialised finishes where high specular effects are required. Recommended pigmentation per gal. is 1¾ lb. Manufacturers address is Johnson and Bloy Ltd., Metana House, Hind Court, Fleet Street, E.C.4.

CORROSION RESISTANT COATING

A QUICK drying liquid zinc and rubber latex compound which can be used to protect iron and steel parts against corrosion is now available in America. The coating, which has a high zinc content, is said to dry hard in 40 min. Application is by brush or spray. National Rubber Bureau, 1631 K Street, N.W., Washington 6, D.C.

POLYSTYRENE SURFACE CLEANER

A CLEANER applied on polystyrene surfaces before metallisation is said to greatly improve the adhesion of the metal.

The cleaner forms a primary base coat for the lacquer coat used in the first stage of the metallising process. Its use is said to greatly reduce the amount of rejected stock since defects in the metal coatings on plastics produced by the metallising technique are nearly always due to a failure of the lacquer undercoating to adhere uniformly to the plastic. The cleaner is a development of the Schwartz Chemical Co., Inc., 326 West 70th Street, New York 23, N.Y.

AUTOMATIC COLOUR MIXER

THE automatic colour mixing machine manufactured by the Martin Senour Co. in America, is claimed to be able to produce any required shade or tint of various paint colours. To reproduce created colours basic ingredients must be controlled within rigid limits.

The machine is set and started by hand and takes from 1 to 20 quarts at a setting. Dispensing, mixing and shutting off are automatic. Dimensions are 9 ft. length, 3 ft. width and 6 ft. height.

Lightweight Industrial P.V.C. Gloves.—A new red P.V.C. fabric-supported lightweight glove, type 725, has been announced by James North and Sons Ltd., Hyde, Cheshire. This glove is fabric lined, has a fine texture with increased flexibility and sensitivity of touch and is claimed to have up to fifteen times longer life than the industrial cotton and lightweight leather glove which it replaces. It is 11 in. long with a gauntlet cuff and supplied in a range of hand sizes. The tough, seamless P.V.C. coating does not absorb dirt and oil and is easy to clean. The glove provides good protection against abrasion, but because of the lightweight P.V.C. coating, it is not generally recommended for the handling of corrosive chemicals.

Elliott Brothers (London) Ltd.—A new high-speed digital computer—the 402—embodying many new features has just been produced by Elliott Brothers. The Elliott 402 has fifteen immediate access nickel line registers and a magnetic store holding 94,000 bits. Monitoring and test equipment together with marginal testing facilities are incorporated in the machine itself. Its high speed is attained with only 550 valves and it consequently has a low power consumption.

CELLULAR DUST COLLECTORS

FROM Davidson & Co. Ltd., Sirocco Engineering Works, Belfast, comes an interesting brochure on their cellular dust collectors. Particularly smoke abatement and control is of interest to all urban communities. The dust collectors in question are claimed to be equally suitable for small and large installations—in fact they have made plants containing three cells up to power station size with 250 cells per boiler dealing with gas volumes of half a million c. ft. per min. The horizontal cells or units are grouped together in parallel, each unit being capable of dealing with a certain volume of dust-laden flue gas, and, of course, the number employed depends on the volume of gas to be handled.

The booklet describes the method of the operation of the dust collector, and gives details of the efficiency expected. Of particular interest are the diagrammatic outlines of typical installations. The firm also offer to provide a demonstration of the "Sirocco" dust collector at any time for those with a bona fide interest.

Chromium Diffusion as a Commercial Process*

by

R. L SAMUEL, Ing.Chim., *and*
N. A. LOCKINGTON, M.A., A.R.I.C

IT is only recently that chromium diffusion has been established as a commercial process and today, plants are operating in this country, in the U.S.A., in New Zealand, in France, and elsewhere, based on patented process developed by Diffusion Alloys Ltd. Our object here is to explain how the process is carried out and what results are obtained. Perhaps the simplest way is to draw a comparison with a familiar process such as chromium plating. If we consider chromium plating on the one hand, and chromium diffusion on the other, it is possible to draw up a simple table where the essential differences are clearly apparent.

COMPARISON OF CHROMIUM DIFFUSION WITH CHROMIUM PLATING.

	CHROMIUM PLATING	CHROMIUM DIFFUSION
Equipment.	Tanks—Vats.	Furnaces.
Compound.	Liquid Electrolyte.	Gas (from solid)
Energy.	Electric current.	Heat (thermal dissociation)
Effect of shape.	Shape of articles important. Distance from electrode to be considered (throwing power). Build-up on apex of threads or at sharp corners.	Gas penetrates blind holes or complex structures. Even depth of coating.
Type of coating.	*Pure Chromium*. Deposited *on* surface. Build-up on surface.	*Chromium Iron Alloy*. Diffused *into* surface. Very slight build-up, if any.
Properties of coating.		
I. Physical.	No alloy bonding at interface between plating and base metal. Very hard. Low ductility.	Complete alloying—integral part of base metal. Comparatively soft (if no carbon). Ductile.
II. Chemical.	Resistance to atmospheric corrosion. Decorative finish.	Resistance to atmospheric corrosion. Resistance to heat. Can be mechanically deformed (bent, formed, etc.), welded, etc. Industrial finish mainly.

**Paper presented to the London Branch of the Institute of Metal Finishing on 21st June.*

As mentioned earlier, the operating compound is a gas; a chromium halide (chloride, iodide, fluoride, bromide). This gas may be produced by a variety of methods, either in containers separate from the articles themselves, or by reaction with a compound serving as a packing support for the articles, or even by a combination of both methods. For simplicity's sake, these variations can be called respectively: gas method, pack method, semi-gaseous method.

The equipment and furnaces required for such processes must be capable of covering a temperature range from 800-1,100° C. Their design and characteristics will, naturally, vary according to the process employed.

The coatings obtained on mild steel at a temperature of the order of 1,000° C. for approximately 4 hours, consist of a chromium-rich layer, averaging 25 per cent. chromium and approximately 0·002 in. deep. This coating is ductile, cannot be stripped from its base metal except by dissolving the latter in acid, and presents all the chief chemical characteristics of a high chromium/iron alloy: resistance to corrosion and to thermal oxidation, etc.

The scientific aspects governing the diffusion process and the resulting coatings have been studied for some years. The thermodynamics of the reactions have been the subject of several papers, notably one by Hoar and Groom[1] on chromium chloride. The metallographic aspects have been reviewed by the authors in a series of Papers three years ago,[2] and the general properties of the coatings have been described in a number of publications at intervals during the last ten years.[3, 4] If, however, the basis of chromium diffusion is generally well understood, very little has been published on its industrial and practical aspects. It is the object of this Paper to present a concise and, to our knowledge, up-to-date account of this subject.

The reason for the lack of information on the practical use and technique of chromium diffusion is quite simple: the commercial development of the process on a substantial scale began only a few years ago, and the technique is still fast developing at the present time.

In spite of this, it may be opportune to survey the present state of technical development, even if some of the methods mentioned may prove to be obsolete in the near future.

Performance and the selection of material and conditions of treatment

It is not difficult to chromium diffuse (or chromise) a steel article. It can be done in a great variety of ways, but only a few amongst those will provide the best conditions for the actual performance expected of the article.

We may, in most instances, be guided in the choice of conditions by scientific considerations but, in fact, these considerations can only be accepted in full when they have been confirmed by practical experience. This experience has now been gathered over the last few years, and we may, with confidence, discuss some of the more important aspects governing the proper specifications of treatment.

One complication is encountered from the start—the diversity of requirements: Chromium diffusion can be used for three main purposes:

(a) Corrosion resistance.
(b) Heat resistance.
(c) Wear resistance.

Plus, of course, combinations of these properties.

It is not possible to effect a clear-cut separation between each of these properties, and the specialisation in requirement can only be a matter of degree. Thus, for instance, a measure of corrosion and heat-resistance is always imparted to an article, even if the primary object is to improve the resistance to wear or abrasion. The selected treatment for wear-resistance for instance, means that the best properties for wear are to be obtained even if at the expense of corrosion or heat-resistance. Then, although there is a relatively large flexibility in the selection of temperature, time, etc., there are definite limits which apply to each type of material undergoing treatment.

We shall confine the discussion of treatment selection to the patented D.A.L. process[5,6] which makes use of chromium iodide and falls within the box process classification.

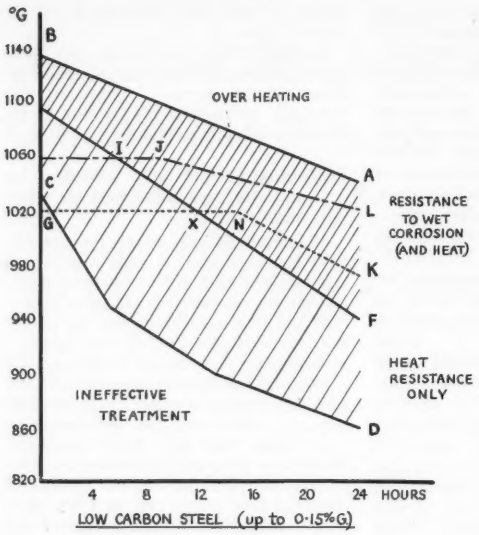


Fig. 1

Figures 1, 2, and 3, illustrate the method of treatment selection in function of requirements for three typical instances of ferrous materials. These diagrams refer respectively to low carbon steel, high carbon steel and cast iron. Temperature is plotted against time of treatment. Curves corresponding approximately to the upper and lower limits of effective processing are drawn (in Fig. 1, CD is lower limit, and AB upper limit). Thus, the area defined ABCD roughly covers the whole range of recommended processing conditions, and is suitable for heat-resisting coatings.

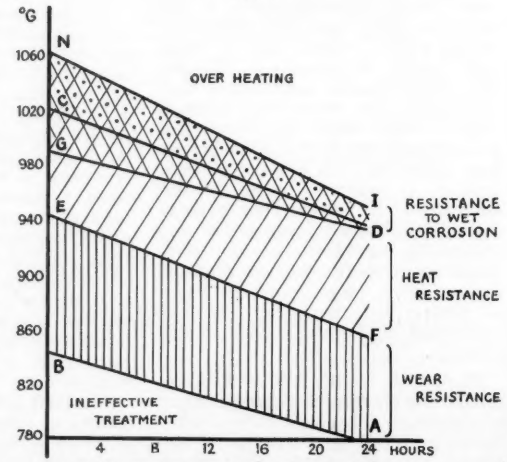
Within this area, curve EF (Fig. 1) corresponds to the lower limit of treatment which can result in coatings of good corrosion resisting properties. Corrosion resistant coatings should, therefore, be obtained within the area ABEF.

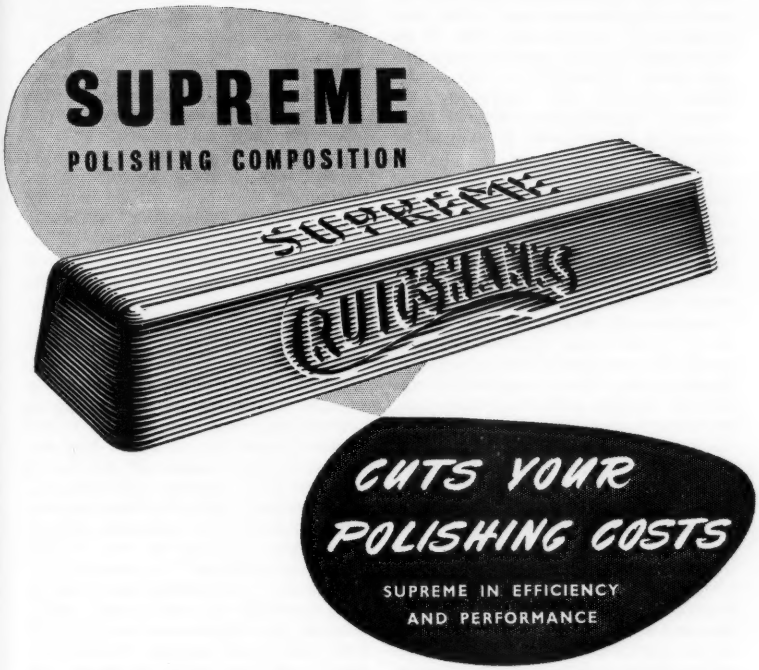
In addition, low carbon steel articles may require mechanical deformation after processing (forming, bending, etc.). Dotted line GHK corresponds to the upper limit of treatments after which cold forming can be performed on the furnace-cooled article. Line IJL corresponds to similar conditions when the articles have had a core-refining treatment after chromium diffusion.

Thus, for example, if an article must have maximum corrosion resistance and be cold-formed after treatment without core-refining, the processing conditions should be selected within the area FXHK. If this article is required for heat-resistance, the processing conditions can be selected within the area DGHK.

Figure 2 (high carbon steel) defines zones of wear-resistance, heat-resistance and corrosion-resistance; in

Fig. 2





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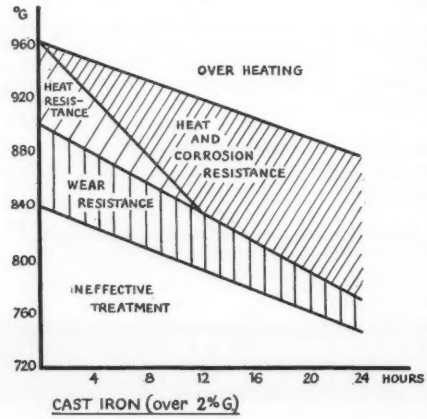
addition, curve CD corresponds to the upper limit of treatment allowing for satisfactory heat-treatment after processing. It can be seen that if an article made in high carbon unalloyed steel must be corrosion resistant and fully hardened after processing, the range of possible treatments is comparatively limited, and is defined by area DGC.

Figure 3 (cast iron) is somewhat similar to Figure 2, but the temperatures are generally lower. There is no limitation due to the necessity of subsequent hardening, and the selection of treatment conditions is accordingly simpler.

Such simple diagrams can be established for all types of steel specifications, but it should be noted that alloying may affect considerably the limiting curves and, in consequence, the area of possible processing conditions, for a given type of application.

In practice, steel specifications can be divided into five or six broad groups, for each of which a typical diagram can be drawn up. These diagrams are essentially qualitative and whilst they are very useful in determining quickly a suitable range of treatment, some caution must be observed in the final selection. In particular, the areas defined for instance as "corrosion resistance" may not refer to identical properties for different materials. Unalloyed steels 0·3 to 0·5 per cent. carbon, particularly with high sulphur content, cannot be made as corrosion-resistant as steels with 0·05 to 0·1 per cent. carbon. Against this, their heat-resistance is roughly equivalent.

Fig. 3



It will be clear from the above remarks that the selection of the base material plays a most important part when the best performance is to be expected. This is, of course, a fundamental feature which is more marked with a diffusion process than with any other surface treatment since the underlying metal forms part of the coating itself. This point will be emphasised in the following sections.

Industrial Chromium-Diffusion

The DAL process, as previously described, is based on a box method whereby the articles are packed in contact with a chromium-bearing compound in the powder form.[5,6]

Box designs are shown in Fig. 4.

The essential feature of this box is the method of sealing which must ensure perfect insulation between the interior of the box and the furnace atmosphere.

This is achieved by means of a fusible seal which allows escape of excess gases generated in the box during heating, then fuses and forms a liquid seal during the soaking period, and finally solidifies as a gas-tight seal when the box is removed from the furnace.

The box is introduced in the furnace, either cold or already at temperature, and maintained at processing temperature for a period varying between two and twenty hours or more. Time and temperature of processing are determined according to the nature of the material and its intended uses.

With the box method, such as the DAL process, conventional furnaces can normally be used provided their temperature range is of the order of 800°-1,100° C. Normal oven-type furnaces, which are in common use in heat-treatment shops, are often used.

In some cases, particularly when heavy loads are to be handled, movable hearth furnaces of the bogie-type are used with good results. Electric

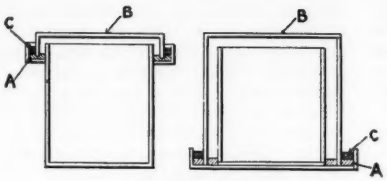


Fig. 4
Two Types of Chromising Box Employed in the Diffubrite Process.
A. Refractory Seal. B. Box Cover. C. Fusible Seal

furnaces are also in use, and a few units fitted with "Kethall"-type elements are in operation in France, and have proved successful in every respect. Finally, plans are being made for the use of conveyor furnaces for large-scale continuous operation. The use of gas-tight boxes makes this adaptation comparatively simple, as there is no need for special atmosphere control inside the furnace itself. Furnaces can, of course, be designed for specific purposes and Bell-type furnaces such as those used for copper wire annealing, etc., are particularly well adapted for the industrial treatment of sheets of large dimensions.

For each type of furnace, it is essential to determine in advance the "soaking" characteristics of the charge, i.e., the time required to attain an even temperature throughout the processing box, or boxes. For each type of box, in a given furnace, an approximate chart can be established, showing at what rate the temperature should be increased in order to achieve a complete permeation of heat in the box without overheating the sides. Such a practice is in current use for box carburising, but it should be noted that the conductivity characteristics of the chromium-rich compound are very different from those of charcoal, for instance.

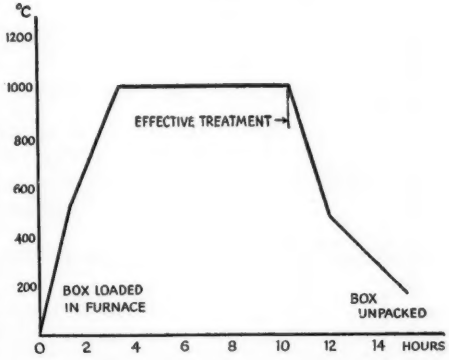
As an illustration of typical treatment conditions, Fig. 5[2] shows a time/temperature graph for a box weighing approximately 2 cwt. introduced into a hot furnace. It can be seen that 4 hours are required for attaining soaking at 1,000° C. The effective treatment of 5 hours starts from that moment.

The compound, which is in powder form, must be regenerated to its full strength after each operation. This is done by addition of fresh compound in proportion of 5-15 per cent. by weight of compound in use. The correct percentage of regeneration can easily be determined by means of a chart, as shown on Fig. 6.[2] This chart established partly from consideration of chromium uptake and partly through practical experience, ensures that there is always an excess of active chromium in the compound.

Furnace Space Utilisation: The most significant single factor in the commercial operation of a process such as chromium diffusion is the economical utilisation of furnace space.

It is, therefore, essential in order to derive the maximum output from the process to ensure that boxes are filled to the optimum capacity. In this respect, the use of a powder compound is a considerable advantage. When gases have to circulate, as for instance in the case of a gas method, it is necessary to provide a sufficient free space between articles in order to ensure that the reaction takes place along the whole surface; furthermore, some turbulence is required in order

Fig. 5



TYPICAL TIME/TEMPERATURE CYCLE FOR CHROMIUM DIFFUSION OF MILD STEEL

to remove the products of reaction and to bring in fresh active gases. This implies the use of jigs holding the articles apart inside the retort, or, of granular compound of sufficient grain size to allow at the same time free passage to the gases and support for the articles. In both cases, the available furnace space is reduced considerably.

With powder compound incorporating a gas-generating solid such as ammonium iodide, the proximity of each article is only limited by the particle size of the powder which is usually of the order of 60-100 mesh. Experience has shown that with complex-shape articles, the quantity of powder required in order to give adequate support is well in excess of the diffusion requirements. With flat sheets, stacked on top of each other, the limitation is, on the contrary, the minimum processing compound required. These two types of articles should, therefore, be considered separately:

Articles of irregular shape:

In general, most finished articles fall within this first heading, whilst the others deal mainly with semi-finished material.

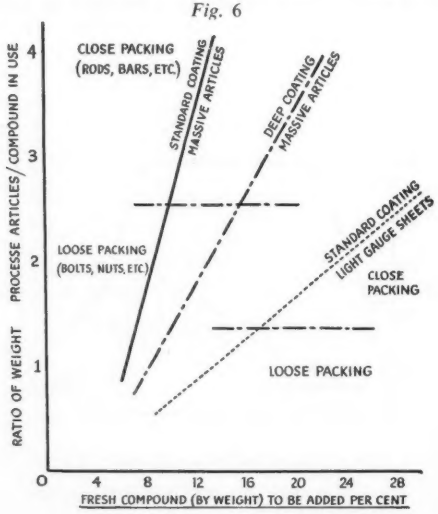
In many cases, with the possible exception of very small parts, the cost of handling is a far less important factor than the space occupied in the furnace. Similarly, the weight of an article is not in itself of great significance, nor is the surface area to be protected. What matters is the total volume occupied in a box by a series of such articles. The configuration of the articles may allow for close packing by offsetting one article in relation to another, or "nesting," etc., but this can only be determined as the case arises.

The only factor which can be calculated is the "maximum encumbrance" of the article which may be defined as the volume of an imaginary box of rectangular section completely enclosing the article.

The packing characteristics of articles such as bolts, nuts, screws, shafts, of varying sections, etc., may be fairly easily assessed by this method. This is not so, however, with formed articles of thin section or fabricated sheet metal assemblies where the maximum encumbrance is out of all proportion with weight and surface. These are obviously uneconomical to treat unless they "nest," or unless they can be processed in conjunction with small parts, fitting into their recessed areas, which belong to a similar group of material.

With small parts, packing may be effected by rotating the parts mixed with an adequate amount of processing powder, in a rotating barrel and filling the box directly from the barrel. This is a convenient method when dealing with small articles of roughly equiaxial shape, such as nuts, etc. With elongated articles, the authors experience is that the saving in handling may well be offset by the loss of box space due to random packing.

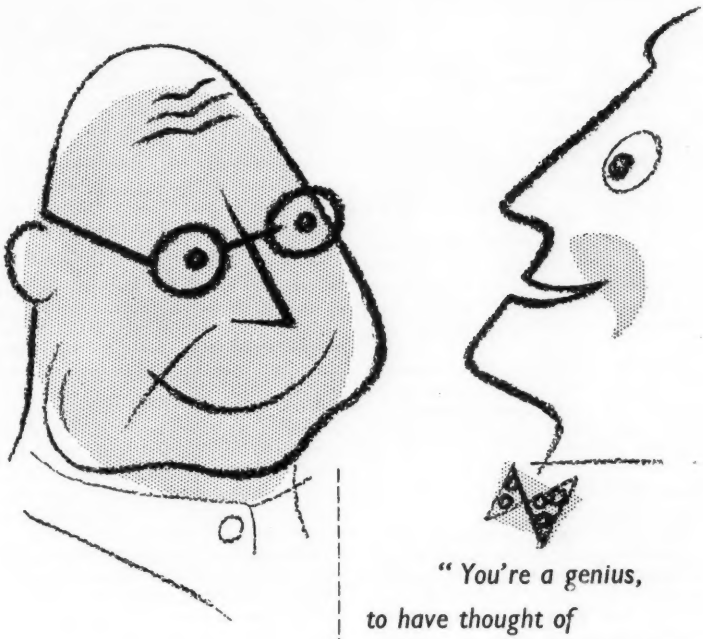
Fig. 6



Regular Sections

This includes: bars, rods, angles, tubes, etc. For all these, individual close packing is the best method. A spacing leaving $\frac{1}{16}$ in. between each part is usually ample and provides a high ratio of utilisation of furnace space.

When processing is



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E.4

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required in the bore, tubes must be filled with compound before packing in the box, and the most convenient arrangement is a vertical or pit furnace.

Flat Surfaces

These include sheets, either whole or blanked to desired pattern, strips and plates. At first, there seemed to be little prospect of processing this type of goods economically in view of the importance of very close packing. This was particularly true of the thinner gauges, as for instance, S.W.G. 18 and over.

In these cases, the weight to surface ratio was very small and all the advantages of the process in economising alloying metals could be more than offset by poor furnace space utilisation.

The use of a powder compound allowed some flexibility in reducing the amount of compound between the sheets, but experience showed that with the type of compound then in use, it was difficult in practice to obtain spacing of less than $\frac{1}{8}$ in. of *regular thickness*.

This point was important, as failure to ensure even distribution of the compound resulted in sagging, leading eventually to contact between adjacent surfaces and consequent insufficiency of diffusion on that area. In addition, there was considerable warping which was sometimes difficult to eliminate by subsequent rolling.

There was considerable potential demand for chromium diffused sheet blanks and strips, provided the treated material could be produced at a price substantially lower than the chromium-iron alloys of comparable gauge. This material is widely used for parts requiring resistance to thermal oxidation within the range of 500-950° C.

The packing problem was solved, at any rate for small and medium-size sheet blanks by the use of a liquid or paste compound, applied to the steel surface between rubber rollers. (DAL Patent Application.) The compound selected for this use contains approximately 50 per cent. by volume of unvitrified kaolin and an equivalent amount of finely divided ferro-chromium. Addition of water to which the ammonium iodide energiser is previously added produces a satisfactory suspension which can adhere to a clean steel surface, and can be subsequently dried in hot air without flaking off.[7]

A simple method was devised to apply this compound to steel sheet blanks. It consists essentially of two motor-driven rollers, the lower roller being immersed to approximately $\frac{1}{3}$ of its diameter in the compound suspension which is contained in a shallow trough. The spacing between the rollers, together with the viscosity of the suspension, controls the thickness of coating to close limits. When suitably set, such a machine can coat between sixty and eighty sheet blanks per minute. As a rule, it requires two operators: one feeding the blanks between the rollers, the other stacking them in groups of thirty to forty in readiness for drying. The drying oven consists essentially of a long and narrow steel frame, lined with refractory bricks and fitted at the lower end with straight gas ramps, the length of the gas flame being set to a few inches only. The top of the frame is fitted with thick wide-mesh gauze; plenty of clearance is left at the bottom to allow ample hot air draught.

With such a method, stacks can be dried in 10-15 min., and two drying ovens as described above will normally suffice to keep pace with the output of one "roller-coating" machine.

Fully mechanised equipment is being designed on the basis of the "roller-coating" method; drying being effected by means of a conveyor belt travelling at a pre-determined speed through a hot-air tunnel. The coated blanks are automatically stacked at the far end of the drier.

In addition to the "roller-coating" method, spraying by means of conventional spray-gun equipment has been successfully applied to the treatment of large sheets, and it is anticipated that this method will be adopted for large-scale processing of sheet metal in the near future. It is possible to control to a very accurate degree the thickness of sprayed compound, and a perfectly even finish can be obtained on surfaces of several square feet. Furthermore, spraying and subsequent drying lends itself to full mechanisation and is, therefore, a convenient method when dealing with large surfaces in quantities.

Finally, for certain applications,

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methods of "dry-coating" are being investigated and appear to show promise as a potential alternative for the methods described earlier.

As a result of the improved packing methods, the treatment of sheet material, from a doubtful prospect at the onset, has now become a substantial percentage of the turnover of chromium diffused material.

Compound costing thicknesses of the order of 0·010 in. are currently obtained, allowing a maximum gap of about 0·020 in. between sheets or blanks and, in consequence, the useful weight of articles per cu. ft. of furnace space becomes as high and often higher than with close-packed solid articles.

Admittedly, the rate of regeneration of the compound (by addition of fresh powder after each run) must be increased in order to compensate for the small weight-to-weight ration, but experience has shown that this factor is only of secondary importance in relation to the overall saving achieved by maximum utilisation of furnace space.

Typical Applications

The commercial application of chromium diffusion can best be illustrated by selecting a few typical instances.

Resistance to atmospheric and wet corrosion

1. *Sheet metal parts* (EN.3A. 0·17 per cent. carbon).

These were processed for twelve hours at 1,040° C.

The plates were immersed in synthetic sea water covering approximately half the plate surface. The volume of solution was regularly made up by adding distilled water. Loss in weight was measured at intervals after carefully washing and drying the samples.

COLD SOLUTION.

	Loss in weight gms.	*Loss/unit area gms./cm.²*
After 48 hr.	0·0003	0·000020
„ 100 „	0·0009	0·000061
„ 200 „	0·0016	0·000107
„ 300 „	0·0016	0·000107

HOT SOLUTION (200° *F.*)

After 100 hr.	0·0007	0·000047
„ 200 „	0·0017	0·000108

This indicates a high degree of corrosion resistance under the conditions of test.

2. *Sheet metal loud speakers* (mild steel).

Three types were prepared:

(a) Phosphated by proprietary process and stove enamelled.

(b) Chromium-diffused, one half left as processed, the other stove enamelled, on top of chromium coating.

(c) Stove enamelled without prior surface treatment.

After two months exposure to winter weather conditions, the results were as follows:

Type (a) Two areas of rust due to damage to the joint and phosphate coating at contact with spring steel washer.

Type (b) No corrosion on either side.

Type (c) Very heavy corrosion.

3. *Mild Steel Terminal posts and nuts for switchgear*

These were chromium diffused and subsequently heated to 550° C. for 30 min. to simulate conditions of use. They were then submitted to 100 hours salt-spray test together with similarly heat-treated stainless parts in 12-14 per cent. Cr. steel.

The appearance of the chromium diffused material was better than that of the stainless material.

4. *Compressor Blades* (Chromium-molybdenum alloy steel).

Aircraft compressor blades made in steel of composition:

Carbon	0·25-0·35 per cent.
Chromium ...	0·5 -0·8 per cent.
Molybdenum ...	0·15-0·25 per cent.

were chromium diffused and heat-treated to recover physical properties. They were exposed to salt-spray test and developed very small isolated pin-points of rust after twenty-four hours; these did not enlarge to any extent during the test period, and serious attack only developed after more than 350 hours exposure. This result is superior to the standard obtained on the usual stainless material used for

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this purpose (carbon 0·12 per cent., Chromium 12-13 per cent.).

5. *Heat-exchanger Tubes* (M/S).

These tubes, of T.26 specification, 20 S.W.G., $\frac{1}{16}$ in. o.d., were chromium diffused in 3 ft lengths. Salt-spray tests showed only two pin-points on one of the ten specimens after fifty hours spray, and fifty hours rest. This was considered to be a very satisfactory standard.

Mention can be made of sink units, fire engine pump parts, telephone and wireless fittings, etc., which are now currently processed in this country and in France, U.S.A. and New Zealand.

Resistance to oxidation at elevated temperature

400° *C.* Screws, washers, studs, used in drying ovens are required to operate continuously at 300-400° C. in a corrosive atmosphere. Such chromium diffused mild steel parts have proved entirely satisfactory in service over long periods. The parts do not tend to seize by rusting. Cleaning and reassembly offers no difficulty. Other examples are: bakery oven parts, gas and electric infra-red dryer panels, etc.

600° *C.* T.26 tubes for heat-exchangers, chromium diffused. Long exposures to air at 600-650° C. and to sulphur dioxide fumes do not result in any measurable weight increase due to oxide formation. Only discoloration is noticeable.

700° *C.* Systematic tests have been carried out for periods of up to 1,000 hours at that temperature.

Fig. 7 illustrates graphically the relative rate of oxidation as measured by weight increase between various types of coatings applied to mild steel.[8] As an indication, the relative weight increases for uncoated mild steel and chromium diffused mild steel are given as follows:

	Weight Increase	
	100 *hrs. at* 700° *C.*	1,000 *hrs. at* 700° *C.*
Mild Steel	40·4 mg./cm.²	147·7 mg./cm.²
Chromium diffused mild steel	0·04 mg./cm.²	0·15 mg./cm.²

A practical instance is that of agitators or fans operating in oil-fired muffles.

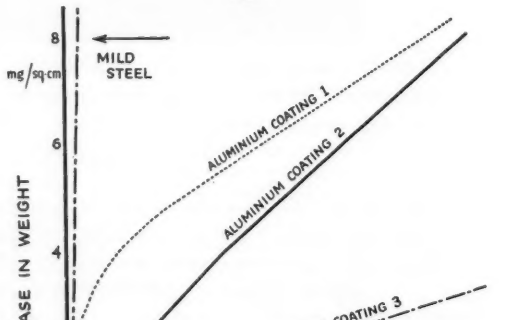
800-900° *C.* Chromium diffused steel is now used on a considerable scale in replacement of 14-20 per cent. chromium stainless iron for a large number of applications where a temperature of that order is encountered.

One instance is that of grill frets for gas cookers where the average temperature of use is assessed at around 850° C.

Several thousand hours of intermittent heating and cooling for 15 min. cycles can be attained without failure of the parts. This represents over ten years actual use in the home, and is fully equivalent to the performance of high-chromium stainless iron.

Over 900° *C.* A good measure of protection can be obtained with chromium diffused mild steel, but the

Fig. 7



rate of oxidation is naturally much increased. Alloy diffusion of chromium and aluminium improve performance at temperatures up to 1,050° C.

Gas pokers, used under normal conditions are estimated to last at least six times as long as the untreated blade. Under destructive test conditions, the life is at least trebled.

Specialised Applications calling for heat-resistance

1. *Moulds for the Glass Industry* (See Glass Journal).

Chromium diffusion considerably improves the performance of moulds used in the glass industry.[9] The following figures illustrate this point on a few types of moulds:

(*a*) *Neck-rings for Bottle* (Cast Iron)

Untreated: Normal performance: 25,000 operations without lubrication.

Chromium Diffused: 300,000 without lubrication.

The cleaning is much easier than on the untreated part.

(*b*) *Plungers*: (Cast Iron)

Untreated: Total life eight days. Dismantled, cleaned and reset every two days.

Chromium Diffused: At least one month. Light cleaning on machine every three days.

2. *Soldering Jigs*

Chromium diffused parts are currently used for soldering or brazing jigs, as the high chromium surface is not wetted by the molten material when normal fluxes are used.

Resistance to Wear

1. *Weighing machine parts*

A combination of wear resistance and corrosion resistance is required on the working parts such as knife edges, vee blocks, etc. These are made in EN.32 case hardening steel, carburised to 0·060 in., then chromium diffused at 880° C. for 12 hours and fully heat-treated to a case-hardness of 60-62 Rockwell C. In the course of approval tests, a machine fitted with chromium diffused parts was subjected to 72 hours bumping test without damage or wear to the working parts. Unprotected edges would have been unserviceable after a few hours.[10]

2. *Fuel Injection Orifice Plates*

Orifice plates in high carbon steel (EN.8) were chromium diffused and fitted to fuel injection burners for marine engines operating on creosote pitch. The treatment given was 12 hours at 1,040° C. These plates were tested in service on liners for over two years, and have proved very much superior to the untreated plates used as comparison.

The wear and erosion at the orifice and along the feeding grooves was a fraction of that previously experienced.

3. *Steam Trap Body*

This is shown on Fig. 8.[11] Made from Hexagon bar in SAE.1117 steel chromium diffused parts produce the same results as the stainless steel originally used to withstand steam erosion and corrosion.

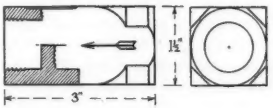


Fig. 8

4. *Countersunk Cutters* (Cast Steel)

Chromium diffused cast steel cutters, subsequently heat-treated are used on chromium plated brass with a performance estimated at five times the life of the untreated tools.

5. *Wood-cutting chain saws*

Links made in 1 per cent. carbon cast steel, chromium diffused and hardened (treatment 880° C.), are used on portable wood-cutting chain saws. The surface hardness considerably reduces the wear and improves the performance in service. The corrosion resistance is also an advantage in periods of storage, when atmospheric conditions might damage the cutting edges.

The above examples are only a few of present-day uses of chromium diffusion.

Some of the earlier important applications have been described in detail in technical literature.[12] They cover a very wide field: Bolts, nuts, threaded parts for food, plastic, elec-

trical industries; Tubular heating elements (electrical); Heat-exchanger tubes and fittings; Paraffin, gas heater parts; Parts for sparking plugs, etc.; Band-saws and tools for light alloys and plastics.

The list is already long, and new applications are constantly being developed.

Conclusions

Chromium diffusion has now attained a recognised place among surface treatments. One would hesitate to call it essentially a finishing process; it is being used in many cases on finished articles, but it has important applications at an intermediary stage of production. This is particularly true with sheet metal parts which are preferably processed in flat blanks and subsequently formed and fabricated to the required design.

It is also important to realise the influence of the basic material upon the quality of the eventual coating. The surface alloy depends for its composition, continuity and general properties upon the nature of the underlying metal; the latter provides the base into which chromium is alloyed. In this respect, the importance of selecting a correct material for processing is more critical than it is when a deposited or "plated" coating is considered.

This is a feature which applies to all diffusion processes: one would hardly consider nitriding or even carburising without some prior selection of the steel composition.

From this, it follows that there is always a great advantage in considering chromium diffusion and its attendant requirements at an early stage in planning. Some slight modification in the choice of material or in the design of fabrication method may well result in major improvements of performance and in substantial economy in treatment.

This, of course, can only be achieved when planning engineers and development metallurgists have acquired a "working knowledge" of the processing requirements.

Chromium diffusion is not a substitute for "plating," nor a pure and simple replacement for stainless steel. It is a process with a specific field of applications which may develop with both, but which is fulfilling a variety of requirements not covered by any other material. In most cases, it is not a question of merely replacing one surface finish by another, but to reconsider the sequence of manufacture and selection of material in function of the anticipated economy and improvement in performance. The scope and limitations of the process can already be foreseen, but some time will elapse before the exact realm of application is defined and this will, to a large extent, depend upon the designers taking full advantage of this new processing technique.

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Rotowash Spray Booth.—A new illustrated leaflet of Heat and Air Systems Ltd., describes their Rotowash spray booth, showing, diagrammatically, the dual suction over and under the water curtain.

AN INVITATION

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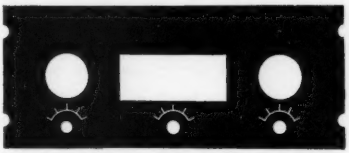

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WARPING IN ENAMELLING

A short analysis of this problem in enamel finishing with suggestions of how it can be overcome

MANUFACTURERS of enamelled covering plates for stoves often experience plate warpage during firing. Some of the most common contributing factors to this trouble are selection of metal, firing temperature, application of enamel, design and support of the plate in firing.

Selection of a suitable steel is all important. Those chosen should be highly resistant to sagging and have a high critical temperature to minimise the possibility of warping. Special enamelling irons have been developed and their analysis have the following range:

	per cent.
carbon	0·015-0·020
manganese	0·030-0·040
phosphorus	0·005-0·010
sulphur	0·020-0·030
silicon	traces

Critical temperature for these is about 1,600° F., and this is above the firing temperatures used today in most enamelling operations. These steels possess excellent resistance to sagging and warping.

Mild steels are also considered suitable for the same enamelling purposes and they are usually of the low carbon open-hearth type. Typical analysis limits are:

	per cent.
carbon	0·050-0·120
manganese	0·30 -0·350
phosphorus	0·010-0·015
sulphur	0·030-0·35
silicon	traces

Steels usually have better drawing qualities than the irons, but because of their lower criticals are more susceptible to warpage during the enamelling process.

Sagging and warping qualities of metals being considered for enamelling should be determined by test.

Firing Temperature

The firing temperature is dependant upon the frit used and it should be below the critical temperature of the metal employed if warping is to be kept at a minimum. Currently, frits are being used that are fired at temperatures from 1,520° F. to 1,550° F. for this reason.

Internal Stresses

Stresses set up in the metal during punching and forming operations often cause warping and distortion during firing. Consequently, fabricated parts are given stress relieving thermal treatments prior to enamelling.

Application of Enamel

Warping may result from too heavy an enamel coating on one side and too thin on the other. Experimentation with various coating thicknesses on each side can reveal a combination which tends to reduce warping. Care must be taken, however, to avoid too thick a coating.

Design Considerations

In designing a piece that is to be enamelled, consideration should be given to the possibility of sagging. This means using the proper thickness of metal and flanges to provide structural strength. If the metal is too thin or reinforcing is not used, warping and sagging will be excessive. Parts of sheet metal should in general be reinforced with flanges at least $\frac{3}{8}$ or $\frac{1}{4}$ in. deep.

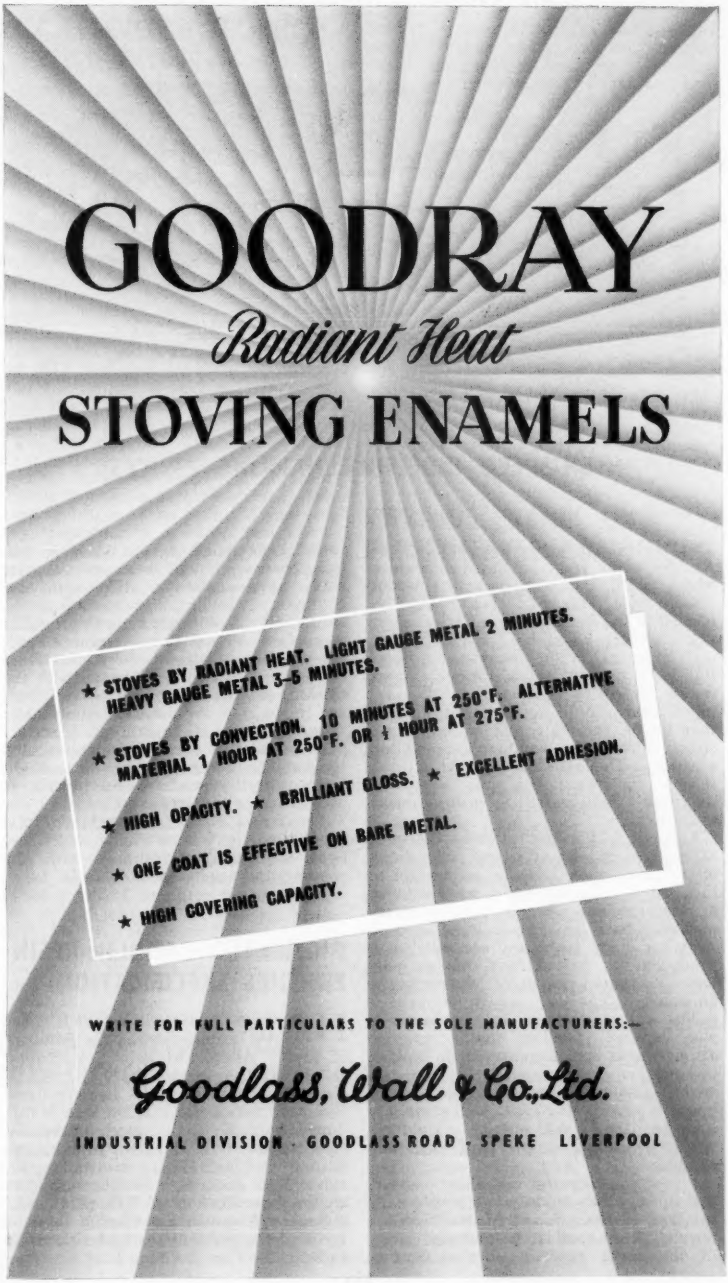
Support During Firing

Proper support of the piece during firing is a good production practice. Using an "A" frame under a part provides suitable support.

International Paints (Holdings) Ltd.—We have received a copy of the 1953 Shareholder's Report of International Paints Ltd., Grosvenor Gardens House, S.W.1. In a photographic section illustrating some uses to which the paints have been put, examples of marine, oil installation and building applications are given.

New T V Tower.—The new T V tower which B.I.C.C. are to design and erect for the B.B.C. at Crystal Palace will be fabricated by Painter Bros. at Hereford. The structural members and connections will be hot dipped and galvanized at their works.

"Marvex" Electric Pulley Block.—We regret that the name of the manufacturer of the "Marvex" electric pulley block was incorrectly given as Graham and Gillies Ltd. This should, of course, have been Geo. W. King Ltd., Stevenage and Hitchin, Herts, England, who are well known for this type of equipment.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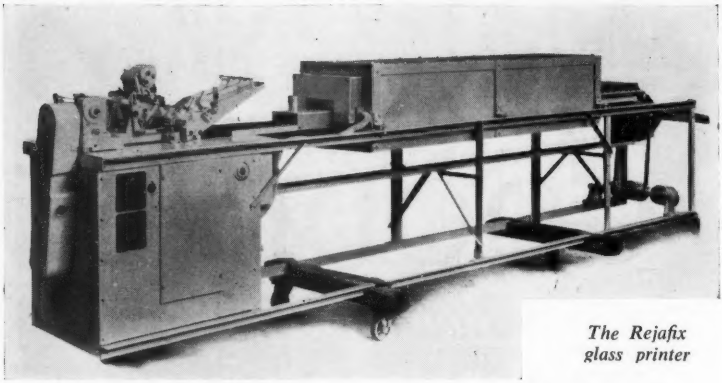

The Rejafix glass printer

HIGH-SPEED INDELIBLE MARKING PROCESS

PRINTING on cylindrical surfaces has for many years presented difficulties which, until the war, were by-passed rather than solved. Tins could be printed in the flat and formed afterwards. Plastic boxes could be "printed," to a certain extent, in the moulding process. But glass bottles, phials, ampoules and (more recently) extruded aluminium tubes, which could not be printed other than on the formed container, had to be either laboriously hand-embellished or labelled. The problem became critical during the war with the need to overprint shell cases in astronomical quantities.

Largely as a result of their wartime experience in this type of operation, Rejafix Ltd. now have in production a high-speed, fully automatic, power-driven marking machine. Simple, hand-operated machines have been made by this company for many years, and are still being produced for limited runs (the average has a maximum output of 500 markings an hour).

The newest model is fully automatic, with special feeding and conveyor arrangements and is competent to handle upwards of 5,000 articles an hour in metal, plastics, glass, porcelain, cardboard or wood. It equally well prints on irregular and odd-shaped cylinders, sparking plugs, fuses and gelatine capsules.

Printing is taken off a resilient, rubber pad upon which an inked impression of the type of block is automatically transferred. Resilience is the essential basis of the entire process, since it is the rubber's flexibility which takes up the irregularities—though successive articles may have different diameters and contours.

Laboratory work has now produced a method of firing new ceramic inks indelibly into glass. A conventional muffle furnace is fitted in series with the marking machine so that glass containers are rolled into the furnace immediately after printing. The inks, of a special patented character, call for highly-skilled temperature control. They are fused firmly into the surface and remain as permanent as the glass itself.

The initial outlay on machinery and installation is low; running costs are light, comparing favourably with the printing and application of labels.

PIGMENTED LANOLIN-RESIN FINISHES SPECIFICATION

H.M. STATIONERY OFFICE has published, for the Ministry of Supply, Aircraft Material Specification D.T.D. 420C (superseding D.T.D. 420B) for "Matt Pigmented Lanolin-Resin Finishes," price 6d. It is stated that these finishes shall contain lanolin (specification D.T.D. 122B), resin (specification D.T.D. 375C), petroleum spirit, xylole 5 per cent. (B.S. Specification 458), kaolin (specification D.T.D. 374), and pigment. When an anti-fouling finish is specified the pigment shall be zinc oxide to B.S. 254 Type 1 Grade L.

O.C.C.A. SEVENTH TECHNICAL EXHIBITION, 1955

THE London Section Exhibition Committee has announced that the preliminary arrangements for the Seventh Technical Exhibition, 1955, have now been completed.

The Exhibition will take place at the Royal Horticultural Society's Old Hall, Vincent Square, London, S.W.1, from 15th-17th March, 1955. The hours of opening on the first day will be from 3 p.m.-8.30 p.m., the opening ceremony taking place at 3 p.m. On the second and third days, the opening hours will be from 11 a.m.-7 p.m. It is felt that the longer hours of opening on the second and third days will enable more visitors from the country to view the Exhibition, which has increased considerably in size since its inception in 1949.

The theme of the Exhibition will be the presentation of technical advances in those industries supplying the paint, varnish, printing ink, linoleum and other allied industries. The technical advances may relate to new products, new knowledge relating to existing products and their uses or, in suitable cases, existing knowledge which is not generally available in the consuming industries.

The Committee have decided to continue the use of a shell scheme for the stands, which will be slightly larger than the 1954 stands in that 1 ft. greater depth has been added, thus making the floor area of stand units 8 ft. wide by 6 ft. deep. The Exhibitors will be allowed to take more than one unit if desired. Information regarding the stand pattern, which now allows for the full use of side walls, was given in the "Invitation to Exhibit," despatched to companies towards the end of June. Companies who have not previously exhibited and who would like to have their names submitted to the Committee for consideration should write to the General Secretary, Mr. R. H. Hamblin, M.A., Oil and Colour Chemists' Association, Memorial Hall, Farringdon Street, London, E.C.4. (Tel.: Central 2120.)

O.C.C.A. SYMPOSIUM ON CONSISTENCY

THE Oil and Colour Chemists' Association have arranged a one-day symposium to be held at University College, Gower Street, London, W.C.1, on Thursday, 23rd September, 1954.

The general theme of the symposium will be consistency, with particular reference to settlement. In the morning, Professor Stacey Ward, of the Department of Mining, University of Birmingham, will speak on the academic, particularly the mathematical, approach to the subject, and this will be followed by a discussion period. After lunch, Mr. J. Pryce Jones will introduce the interpretative aspect of the subject and will illustrate his points with results obtained from modern gloss paints. The discussion will be opened by a number of short contributions dealing with various practical aspects of the subject.

The cost of tickets for the symposium to members of the Association will be 5s. each and to visitors, 10s. each.

Catering facilities have been arranged so that members and visitors can obtain luncheon, if so desired, in the upper refectory of University College, at an additonal charge of 5s. 6d. Information can be obtained from the General Secretary, Mr. R. H. Hamblin, M.A., Oil and Colour Chemists' Association, Memorial Hall, Farringdon Street, London, E.C.4. (Tel.: Central 2120.)

VITREOUS ENAMEL ON EXPERIMENTAL ROAD SIGNS

THE high annual cost of maintenance of road signs has encouraged a move in Scotland towards development of a tougher, more resistant road sign. Vitreous enamel finish is being used currently on several experimental projects with a view to determining reaction of county and town authorities. Initial cost must of necessity be higher, but against this there is the annual economy which can be achieved by the elimination of regular maintenance in terms of paint and labour. Two items of this type were shown at a contractor's demonstration at Queenslie, Glasgow recently; in one case the standard black/white signpost was shown, finished in vitreous enamel; the other item is an interesting kerb reflecting device, again finished in vitreous enamel, measuring some 9 in. long by 4½ in. deep and designed with six facets to pick up and reflect traffic lights. These plates are intended for particularly dangerous sections of roadway, the intention being to space them so as to signal to the road user the intensity of the angle of bend. The plates can be fitted to any standard kerb and are already in limited use.

Here again the main argument for the more costly finish is that it eliminates the cost of annual survey and renewal or maintenance. Foundries in the Central Scotland area are actively interested in these developments and are fully equipped by reason of their existing casting production to cast and finish at an economic price.

American Finishing Developments

A DIGEST OF THE ARTICLES DEALING WITH FINISHING PROCESSES, WHICH HAVE BEEN PUBLISHED IN U.S.A. TECHNICAL JOURNALS.

Easily Applied Plastic Alloys Provide Low-cost, Corrosion-resistant Finish and Conserve Metal.—Not only are plastic alloys (vinyl plastisols) providing low-cost, corrosion-resistant finishes for numerous items used in many industrial fields, but they may be applied by dipping, spraying, slush-moulding, injection-moulding, or cast in open or closed moulds. This rubber-like material can be coated on paper or fabric, cast into sheet, or spray coated.

New dipping techniques, formulations, and improved adhesives have helped to expand the usefulness of these plastic materials which show promise of saving thousands of pounds of valuable alloying elements each year. Plastisol formulations offer manufacturers a satisfactory tough, resilient, insulating coating for many applications in the metal trades at a reasonable cost; and specific application techniques have been developed to meet special requirements in the aircraft, electronic, automotive, dentistry, and surgery fields.

Composition

Vinyl dispersion plastisols are suspensions of resin in non-aqueous liquids which do not dissolve the resin at ordinary temperatures. They often include stabilisers, pigments, and fillers. Heat is required to fuse the plastisol material into a continuous film. These coatings differ from solution types containing volatile solvents where the film forms by solvent evaporation. When the plastisol is heated to the proper temperature, the solid particles of resin dissolve in the liquid plasticiser, and upon cooling, this forms a rubber-like alloy.

Characteristics

Vinyl plastisols have no adhesion to metal surfaces when cured. If adhesion is required, specially formulated bonding primers must be used.

Although injection-moulding and spraying techniques are employed, dip-coating is the most widely used method of applying plastisols. After the liquid plastisol has taken the desired shape or form, heat is applied to fuse the resins, plasticisers and modifiers into a homogeneous mass.

Temperature is an important factor. It controls the nature of the product as well as the thickness of the coating. Where a thin dip-coating is desired, the article is immersed at room temperature, drained, and cured (or fused) at 350-375° F. Heavier coatings can be formed, either by preheating or re-dipping. Irregularly shaped parts are coated by special formulating, preheating and dipping techniques. Sometimes it is necessary to plunge the heated part into hot oil, glycerine, or wax to congeal the deposit and prevent it from running or tearing. Immersion with withdrawal rate control film thickness and uniformity.

Applications

Besides dipping and spraying applications which provide scratch-proof, cushion-like protective coatings, other uses of vinyl plastisols include: seamless, barrier-type linings for chemical dip or rinse tanks to prevent solution contamination; coating material for plating barrels and steel wire trays or baskets; as a protection to machine-finished transmission parts, and to fan blades that are exposed to corrosive atmospheres, as well as closely dimensioned electronic wiring harness exposed to moisture and fungus; and as a protective coating for metal dies to prevent scratches and marks on surfaces during fabrication. Micro-finished fixtures for aircraft are being protected with a plastisol film.

Another application of vinyl plastics is plastisol-lined metal pipe, which have a resistance to a broad range of corrosive agents.

A coating of 0·020-0·030 in. can be applied to the working surface of metal-forming dies without affecting the temper of the surface finish.

It is reported that grilles built to fit old-model automobiles were salvaged and reformed to fit newer models by first coating them with plastisol of the right hardness and thickness.

An automatic feeding hopper coated on the inside to provide protection for the surface finish of the hopper-fed small parts for sub-assemblies has proved to be an effective approach to cost reduction.

The Iron Age, September, 1953.

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Book Reviews

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ORGANIC PROTECTIVE COATINGS

EDITED by William Von Fischer and Edward G. Bobalek, "Organic Protective Coatings" provides a valuable textbook on the practical and theoretical aspects of paint as an engineering material. Well printed and amply illustrated, this volume stems from a lecture series of the Organic Coatings Division of the American Case Institute of Technology, designed to keep students and technical men of the paint and varnish industries abreast with advances in the coatings field.

This book shows the influence on the development of industrial paints of engineers in other technical arts, suppliers of raw materials, coatings and corrosion engineers and those scientists who provide the practical engineer with fundamental research. Several chapters present the application of chemical and physical theories to coatings technology, others relate case histories of progress in new materials and techniques.

In its approach to the problem of paint formulation and its awareness of economic factors in the selection of coatings for a particular purpose, it becomes of great value to the practical man as well as to the advanced student. Price 60s. net. Chapman and Hall, 37 Essex Street, London, W.C.2.

HANDBOOK OF INDUSTRIAL ELECTROPLATING

THE first edition of *Handbook of Industrial Electroplating*, by E. A. Ollard, A.R.C.S., F.R.I.C., F.I.M., and E. B. Smith, was published in 1947, as a practical and reliable reference book on all aspects of modern electrodeposition plant and plating technique. The steady demand has prompted the authors to undertake a still more comprehensive work, and this greatly enlarged second edition, carefully revised and brought completely up to date, is the result.

This edition contains new sections dealing with water and drainage, the purification of solutions, safety precautions and ventilation in plating shops, and the special problems of coating in such shops. Many new formulæ for solutions as well as details of the latest advances in testing deposits are given, while a number of additional tables for reference have been provided.

The handbook is intended for all those whose duty it is to design, erect, maintain or operate electrodeposition plants, and also for laboratory workers who have to deal with the testing and maintenance of plating solutions. As a useful reference book for the practical metal finisher it is certainly a "must."

The book contains 364 pages, 122 illustrations and seventy-two tables. Priced 30s., it is published by Cliffe and Sons, Dorset House, Stamford Street, S.E.1, for "Metal Industry."

TIN RESEARCH INSTITUTE REPORT, 1953

THE twenty page Report of the Tin Research Institute for 1953 contains information on a number of interesting research projects summarised with their possible applications below:

A New Bearing Alloy

A series of new bearing metals, now undergoing practical trials, contain 30, 20 or 15 per cent. of tin alloyed with aluminium; the two latter may be bonded respectively to strong aluminium alloy and steel backing shells. The 15 per cent. alloy is being prepared for trials by some of the largest manufacturers of automobiles.

A New Tableware Alloy

A new white alloy of copper, manganese and tin which takes a high polish and is suitable for rolling and stamping, may find applications in tableware and in the electrical industry.

Tinplate Studies

The Institute's tinplate researches have again been principally concerned with the

study of the tin-iron alloy layer, since the solderability and the corrosion resistance of tinplate are closely linked with the amount of the alloy and its structure.

Organo-tin Compounds

Chemical compounds of tin, in which the tin atom is directly joined to the carbon atoms of organic radicals, are being systematically studied. In the last few years, some of these compounds have been used as a stabilising ingredient in certain plastics, and the current consumption of tin for this purpose is some hundreds of tons yearly. Another group of organo-tin compounds have biocidal properties, which should lead to applications in wood preservatives and paints. Trials of these organo-tin compounds are being arranged in collaboration with research laboratories dealing with these industries.

Abroad the Institute now maintains Tin Information Centres in the U.S.A., Canada, Belgium, France, Germany, Holland, Italy and Sweden.

The Report is available free of charge from: Tin Research Institute, Fraser Road, Perivale, Greenford, Middlesex, England.

ORGANIC COATING TECHNOLOGY, VOLUME I

THIS book, by Henry Fleming Payne, Technical Editor, American Cynamid Co., surveys the chemistry, manufacture and use of oils, resins, varnishes, high polymeric materials, plasticisers and driers used for clear coatings, and as the vehicle or liquid portion of pigmented coatings.

The author has placed emphasis throughout on the practical aspects of his subject, and the book contains a great many specific formulations showing the actual use of the materials discussed. The formulations are based on commercial materials which he refers to by their trade names for easy identification.

Primarily intended as an introductory manual for new technicians in the oil, resin, pigment and paint industries, the author has included in his book a concise discussion of basic theory to provide an understanding of the many physical and chemical phenomena associated with the drying of oils, the resinous state and the production and behaviour of high polymers.

In this work there is much in the developments and procedures outlined by Mr. Payne, to interest the advanced and specialised chemist and technician as well as the student. Price 80s. net. Published in England by Chapman and Hall Ltd., 37 Essex Street, London, W.C.2.

CODE FOR INFLAMMABLE LIQUIDS

THE Association of British Chemical Manufacturers has issued a voluntary code of precautions for the storage and use of highly-inflammable liquids which are not covered by the Petroleum (Consolidation) Act, 1928. The Code, which has been prepared by the Works Safety Committee of the Association, and is recommended for acceptance by all of the Association's members where applicable, is intended to apply not only to factories but to premises used solely for purposes of storing or repackaging.

Based to a great extent on existing statutory regulations for petroleum spirit, the new code contains recommendations which go beyond the requirements of those regulations. Nevertheless, observance of the code does not in any way detract from the obligation to observe any requirements which may apply under Acts of Parliament.

Owing to the diversity of conditions under which highly-inflammable liquids are stored and used in industry, strict compliance with the code will present difficulties in some existing works. The rules should be carried out, however, as far as is reasonably practicable and followed to the maximum possible extent when designing and building new installations.

For the purpose of the code, "Highly Inflammable Liquids" means liquids with a flash point below 73° F., but excluding liquefied gases. As liquids of higher flash point can be just as dangerous they have also been taken into account.

Copies of the code—Safety Circular No. 97—which should be read in conjunction with "Safety Rules for Use in Chemical Works, Part II," published by the A.B.C.M., can be obtained at a price of 2s. (post free) each from the office of the Association, Cecil Chambers, 86 Strand, London, W.C.2.

"Projection Welding of Mild Steel."—We have received from the British Welding Research Association a copy of technique booklet, Ref. T.30, "Projection Welding of Mild Steel." The booklet was prepared by a committee of the association composed of British resistance welding experts and covers all aspects of projection welding. In it recommendations are made to cover machines and electrodes, materials to be used, types of projections and machine settings for various thicknesses of material. The booklet is priced at 3s. 6d. and obtainable from the British Welding Research Association, 29 Park Crescent, W.1.

(*Continued on page* 923)

Something New in Spray Booths

—*Aeroplane "Howdah" speeds painting*

PRODUCTION engineers at Lockheed Aircraft Corporation, Burbank, California, have borrowed a trick from India's elephant-riding Maharajahs in order to facilitate the production of Super Constellation aircraft. It is a mobile, mid-air, paint booth—called a "howdah" because it resembles the elephant saddle of the same name.

The howdah fits like a circus tent over the top of the huge plane's fuselage and carries a crew of spray painters back and forth along its 113 ft. length.

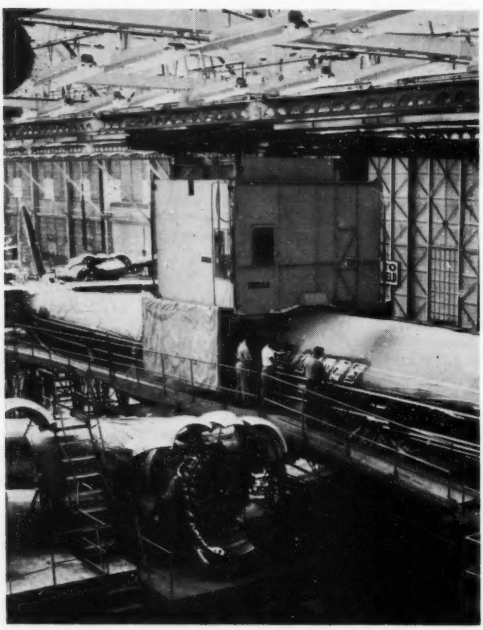
With it, the exterior of the airplane can be finished while final assembly operations take place. Lockheed engineers claim this saves five days in the production of each airplane.

Suspended from an overhead crane, the fuselage-straddling howdah provides a "conveyorised" paint booth which measures 20 ft. high, 13 ft. wide and 13 ft. long. Painters stand on protected sidestands or scaffolds beneath the howdah's hood.

Adaptable for use on many large structures, the versatile spray booth saves the time formerly required (1) to take a plane off the final assembly line and move it to a separate paint building. (2) schedule it on a two-station paint line, and (3) return it for final assembly operations.

Specially-designed exhaust and automatic fire extinguishing systems eliminate potential fire hazards. The exhaust system automatically sucks up all paint residue and fumes through a filtered vent in the roof. The fire extinguishing system sounds an alarm if temperatures within the howdah reach 160° F.; then ten seconds later, it actuates carbon dioxide fire extinguishers.

Emergency ladders and ropes enable finishers to get out of the booth in less than 10 seconds.



"Howdah" spray booth in use at Lockheed Aircraft Corp., Burbank, California, for spraying aircraft fuselages

READER SERVICE SECTION

Items in the following list of manufacturers' literature are available as a personal service to readers of INDUSTRIAL FINISHING *by using the reply card below.*

In addition, the editorial staff of INDUSTRIAL FINISHING *are always available as an advisory service on questions affecting finishing.*

Asbestos and Bitumen Roofing: Technical handbook on Nuralite, a durable waterproof material which has all the essential qualities and functional range of roofing metals. Handbook gives technical data and extensive information on the methods employed to use the material for all roofing jobs. Nuralite Sales Ltd., 3-4 Whitehall Place, Gravesend, Kent. (90)

The 600 Group. Well illustrated and comprehensive booklet describing the scope of the activities of the 600 Group of Companies. Describes the many products handled and services provided by the group. George Cohen Sons and Co., Chase Road, Acton, London. (91)

Spray Equipment. Catalogue booklet of a specialist firm in spray engineering gives information on spray nozzles for a wide variety of purposes, many of interest to finishing firms. Details of pumps and strainers are also given, together with technical data sheets. H. T. Watson Ltd., Victoria Road, Widnes, Lancs. (92)

Rotowash Spray Booth. Brochure with photographs and cut-away diagram explains main features of a waterwash spray booth which has a dual air intake of both over and under the water curtain. Some illustrations of down draught type booths are given in addition. Heat and Air Systems Ltd., Coastal Chambers, 172 Buckingham Palace Road, London, S.W.1. (93)

Cold Galvanizing Process. Technical memorandum and coloured pamphlet describe the properties, advantages and limitations, and application of the "Galvafroid" cold galvanizing method of

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protecting iron and steel against corrosion. Although brushing is claimed to be the best method of application a spraying grade is available. Normal application results in a light matt grey finish which provides a good base for any decorative coating or finish if required. Secomastic Ltd., 15 Upper Grosvenor Street, Park Lane, London, W.1. (94)

Paints. Attractive coloured booklet describes with illustrations methods of paint production and technical services to the customer. Pocket in the booklet contains data sheets on zinc rich, chemical resistant, bituminous, chlorinated rubber and synthetic resin emulsion paints, enamel finishes, priming treatments and a dielectric compound. Drynamels Ltd., Shaftmoor Lane, Hall Green, Birmingham 28. (95)

Polymotion Machine. Booklet illustrates and supplies technical data on the use and performance of barrel machine for polishing, descaling, deburring, grinding, honing and colouring. Rubber lined, with curved inner surfaces, these machines work with eccentric rotary movement. Working loads vary from ¼ cu. ft. and 80 lb. of steel, or equivalent, to 2¼ cu. ft. and 320 lb. Range of media is available for wet or dry barrelling for types of processing from deburring to fine polishing. Fox Chemical Engineering Works Ltd., Maybury Gardens, Willesden, London, N.W.10. (96)

Cordage Preservatives. Booklet explains the uses and properties of cordage preservatives containing oils obtained from Mond tar, having a high percentage of phenoloids of great fungicidal and bactericidal value. Melanoid Ltd., Dudley Port, Tipton, Staffs. (97)

Decorative and Machinery Paints. A number of technical data sheets give information on enamels, hard gloss, plastic emulsion, flat oil and washable oil-bound water paints. Of particular interest is the one on machinery paint for use where a brilliant, hard wearing, weatherproof, oil heat acid and water resisting glossy finish is required; colour range is shown. Walter Carson and Sons Ltd., Grove Works, Lombard Road, Battersea, London, S.W.11. (98)

Hot Spray Process. An eight page memorandum deals with possible benefits in economy, quality, increased production and better health which can be obtained through using hot spray, and how these benefits may be achieved. T.C. Spray Finishing Systems, 5 St. James Place, S.W.1. (99)

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EPIKOTE RESINS TO BE MANUFACTURED IN ENGLAND

"EPIKOTE" resins, the latest addition to the rapidly-expanding range of chemicals from petroleum, will be manufactured for the first time in England when a new plant now under construction is completed next spring.

Although their first manufacture in Europe was undertaken only a year ago by Shell at Pernis, near Rotterdam, the demand for these resins has been so heavy that Shell are installing an Epikote unit at their Stanlow Chemical Plant in Cheshire. This unit will increase manufacturing capacity to keep pace with demand and ensure that these versatile products are available to British industry from home production.

Epikote resins have wide application in finishes for food containers, washing machines, refrigerators and similar articles and in the electrical industry. Epikote-based finishes are distinguished by great flexibility, abrasion resistance and adhesive power. When applied to furniture, for instance, they give protection against wear and tear, corrosive chemicals, alcohol and even neglected cigarette ends. Food tins and similar containers can be painted with these materials, crushed before consignment to save storage space in dispatch and expanded and re-formed at their destination with undamaged surfaces. Epikote-based paints, by virtue of their weathering qualities and protective powers, are of great value in the maintenance of industrial plant.

With increased production from the new plant it is expected that Epikote-based paints will in time become available for household use.

SCHORI'S NEW GLASGOW FACTORY

SCHORI METALLISING PROCESS LTD. have taken over a factory at Kelvin Avenue, Hillington, Glasgow, to operate a full rate of anti-corrosion services using the Schori process and equipment. The new premises will permit a full service for Scottish clients and have been laid out to allow a complete jobbing service, either for equipment sent to the plant, or for processing on the site. Equipment has been installed to cover the full range of services with emphasis on the spraying of zinc, aluminium, and tin. It is also hoped to extend into the plastic spraying field on a large scale in Scotland at a later date. The location of the new plant is particularly helpful in that machinery or equipment due for export can be routed through the new Schori factory and then shipped from that point.

Schori have already done a considerable amount of work in Scotland and the location of this new factory is a further development of that service. It is slanted at the shipbuilding, structural and engineering, machinery, and allied interests. Manager at Glasgow is Mr. J. Nesbit.

C.D.A. COMING-OF-AGE

SPEAKING at a luncheon held recently at Kendals Hall, Radlett, Herts, to mark the coming of age of the Copper Development Association, Lord McGowan, K.B.E., remarked that because he had been a friend of the C.D.A. since its inception he was well aware of how successful it had been during the past twenty-one years. The membership had risen from twenty-five to thirty-four, and as the years passed, more and more people, not only in this country but in many other countries, had come to recognise in the C.D.A. a guide, philosopher and friend. The C.D.A. technical staff were among the best in the world for the job they had to do and had at their fingertips, in the well-organised reference library, a comprehensive system of information carefully culled from the world's leading publications on the subject.

As another invaluable part of its work, the C.D.A. acted as watch-dog on behalf of the copper-using industries over a wide range of standardisation activities. Members of the staff served on more than sixty technical committees and sub-committees of the British Standards Institution.

Lord McGowan made a plea for a closer association of science with industry. The C.D.A. could well congratulate itself on the work it was doing in that sphere. Other industries might lag behind technologically because they had never set up machinery to make the results of research known to individual concerns in their particular field. That was not true of copper. It said much for the industry that it saw the need for such machinery as long ago as 1933, and by forming the C.D.A. took steps to meet it.

Mr. R. L. Prain, O.B.E., Chairman of the Council of the Association, announced the setting up of a trust fund to secure the future of the Association. The fund, which would amount to not less than £100,000, would be subscribed by the following—Roan Antelope Copper Mines Ltd., Mulfulira Copper Mines Ltd.,

Nchanga Consolidated Copper Mines Ltd., Rhokana Corporation Ltd., and the British South Africa Company.

NEW B.S. FOR CHILLED IRON SHOT AND GRIT

THE primary purpose of this British Standard (B.S. 2451 : 1954) is to assist in overcoming the difficulties which have been experienced by users in obtaining uniform grades and sizes of chilled iron shot and grit for use in shot blasting and kindred applications.

The main object in preparing the Standard has, therefore, been concerned with the separation and sizing of the chilled shot and grit and designating grade and size numbers. It has also been considered desirable to include requirements for hardness.

The Institution desires to point out that the term "steel shot and grit," which is commonly used in certain sections of the trade, is a misnomer and strongly recommends that its use be discontinued. The correct term is "chilled iron shot and grit."

The grades and sizes of chilled iron shot and grit covered by this Standard have been designated 7, 8, 9, 10, 12, 15, 18, 22, 30 and 40.

Screen sizes and tolerances are given to determine the particle size.

Copies of this Standard may be obtained from the Sales Branch of the Institution, British Standards House, 2 Park Street, London, W.1. Price 2s.

L.C.C. PAINTING CLASSES FOR SALESMEN

THE L.C.C. Brixton School of Building is providing a series of classes in painting and decorating for paint salesmen, so that they may have some understanding of the processes and materials, the conditions and the difficulties with which they come into daily contact in the course of their work.

The classes will be held on Fridays from 1.30-4.30 p.m., commencing on 24th September, and the fee for the complete course of one session will be £1 5s.

In addition, evening courses will be held in spray painting for painters and decorators commencing on the 27th September. Classes will be on Mondays and Tuesdays from 6.30-8.30 p.m.

Further information may be obtained from the secretary, L.C.C. Brixton School of Building, Ferndale Road, London, S.W.4.

LABORATORY FURNISHERS' MERGER

The directors of Griffin and Tatlock Ltd., and W. and J. George and Becker Ltd., in a joint statement issued on 29th June, 1954, announced the merging of their two organisations, under the name of Griffin and George Ltd. pending administrative and physical integration which will be a gradual process, they will continue to trade, until further notice, under existing names and at present addresses.

Recent Technical Literature

(*Continued from page* 919)

The Bede Hot Spray Process.—We have received from T.C. Spray Finishing Systems, 5 St. James Place, S.W.1, a copy of the Bede Hot Spray Process, an information sheet providing a memorandum for users and distributors. In the sheet an impressive list is given of the claimed benefits of the process. It explains at some length how these benefits may be achieved, and the versatility of hot spray in the requirements which it can meet.

Metal Spraying by the British Wire Process.—We have received an attractive, coloured book entitled "Metal Spraying by the British Wire Process." Published by Metallisation Ltd., Pear Tree Lane, Dudley, Worcs, it deals with the theory and practice of metal spraying, explaining the use of various metals, and contains a great number of illustrations.

Ault and Wiborg Ltd.—Published in attractive, coloured booklet form, the 1953/4 Annual Report of Ault and Wiborg Ltd., Standen Road, Southfields, S.W.18, contains information on their products, their functions and value. The chairman says in his statement that 34 per cent. of the Group's turnover for the year consisted of paints, lacquers, varnishes and industrial finishes.

Styrene Co-Polymers Ltd.—The latest issue of "Scop," the news sheet of Styrene Co-Polymers Ltd., contains a special insert printed with an ink based on Scopol 41, a new styrenated alkyd resin. Copies of the magazine can be obtained on application to the firm at 1 Roebuck Lane, Sale, Manchester.

Left: Chairman of 3M, J. D. MacKensie (centre) with A. C. Ash, director of sales (left) and J. Mann, of Agnew and Mann (Jenolite)

3M OPENS SCOTTISH OFFICE

A COCKTAIL party was held recently to celebrate the opening of a sales office at 90 Mitchell Street, Glasgow, C.1, by the Minnesota Mining and Manufacturing Co. Ltd., manufacturers of abrasives and adhesives. Mr. J. D. Mackensie, Toronto-born chairman, met customers from many industries.

Mr. Harold Gadd is sales manager in charge of the new office.

Appointments

DR. D. ATHERTON is to join the Board of John S. Craig and Co. Ltd., the old-established Glasgow paint manufacturers, in August as Technical Director.

Dr. Atherton graduated and took his Ph.D. degree at Liverpool University, spending five years on vegetable oil research in the renowned Hilditch School. He then joined Imperial Chemical Industries Ltd., Dyestuffs Division, first in the Research Department but more recently became well known to the paint trade through his technical service in the

Names in the News

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Resins Service Department at Dyestuffs Division.

Dr. Atherton is a member of the Oil and Colour Chemists' Association Manchester Section Committee and is a member of the Paint Research Station Media Panel.

Sir Hugh Beaver, M.Inst.C.E., M.I.Chem.E., has been appointed chairman of the Advisory Council for Scientific and Industrial Research in succession to Prof. Sir Ian Heilbron, who retires on 30th September, 1954, on completion of his term of office. Sir Hugh has been a member of the Advisory Council since 1952.

Mr. L. S. Philcox, formerly of Haller and Phillips Ltd., has now joined British Chemical Products and Colours Ltd.

Honeywell Brown Ltd. have announced the appointment of **Mr. D. J. Venning** as District Supervisor of their new Glasgow office. This office, at 26 Blythswood Square, has been established because of the increasing business and expanding factory requirements of the firm.

Nife Batteries, Redditch, announce that the address of their North-east area representative, **Mr. R. W. Allen,** B.Sc. (Eng.), A.M.I.E.E., is now: "Westbourn," Darras Road, Ponteland, Northumberland.

BUSINESS MEN IN THE BIRTHDAY HONOURS LIST

THE Queen's Birthday Honours List, published recently, is the fifth Honours List of her reign. The principal awards include one new Viscount, three Barons, two Privy Councillors, three Baronets and forty-two Knights Bachelor in the U.K. (a number of them prominent in industry and commerce).

A selection from the List, including some awards which are of interest to the business world, is given below:

PRIVY COUNCILLOR

Mr. Arthur Deakin, general secretary, Transport and General Workers' Union. For services to the trade union movement.

KNIGHTS

Mr. A. A. Hall, director, Royal Aircraft Establishment, Farnborough.

(*Continued on page* 926)

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Names in the News

(*Continued from page 925*)

Mr. T. S. Overy, of Allen and Overy, solicitors; director of British International Paper, Metropolitan-Vickers-G.R.S., Powell Duffryn and other companies. For political and public services.

Mr. Frederick Scopes, managing director, Stanton Ironworks; director of Stewarts and Lloyds and other companies. President, Joint Iron Council.

Prof. F. E. Simon, Professor of Thermodynamics, University of Oxford. A contributor on scientific subjects to *The Financial Times.*

C.M.G.

Mr. Alan James Ruthven-Murray, joint managing director, Trinidad Leaseholds; director of Regent Oil, Shell Leaseholds Distributing Company and other companies.

K.B.E.

Mr. I. A. R. Stedeford, chairman and managing director, Tube Investments; chairman of Reynolds Rolling Mills and South Wales Aluminium; director of Atlas Assurance, National Provincial Bank and other companies.

C.B.E.

Mr. T. E. Goldup, director, Mullard, Mullard Equipment and Mullard Radio Valve Company.

Mr. J. F. (Jack) Tanner, lately president, Amalgamated Engineering Union.

Mr. F. H. Lister, a managing director of R. A. Lister and Co.; director, Blackstone and Co.

Mr. T. W. Mathias, general operations manager, Shell-Mex and B.P.

News from South Africa

COMPETITION IN PAINT INDUSTRY WHEN CONTROL REMOVED

WHEN import control is removed, the Union's paint manufacturing industry, with an output of nearly £7,500,000 a year, is bound to feel the competition, says the Board of Trade and Industries in a report on the industry tabled recently in the House of Assembly.

The Board does not recommend that the present protective duties of up to 25 per cent. should be reduced. It considers that under normal conditions, competition will be keen enough to prevent abuse of the protection.

It recommends that the Union should negotiate to be released from its obligation, under the general agreement on tariffs and trade, to maintain the existing duty on synthetic resins.

The industry had developed rapidly since 1939. The Union imported 30-40 per cent. of its paint then but has now become an exporter, and the quality has improved materially in that time.

Threat to Tung Nut Farmers.—Large shipments of Far Eastern tung nut oil are on their way to Europe. Fearing that part of these shipments will come to South Africa, tung nut growers are seeking tariff protection.

Through the South African Tung Producers' Association, they have asked the Board of Trade to recommend that the tariff on imported oil be raised from 20 per cent. to 66⅔ per cent., and that the rebate on the importation of tung oil for industrial purposes be withdrawn.

South African tung nut growers feel that a reasonable price for tung oil would be about £150 a short ton. They say that South African-grown supplies can meet the demand of local industry.

Production of Refined Cadmium.—A new plant is being erected at Broken Hill by the Rhodesian Broken Hill Development Company which will make possible the production of refined cadmium in Northern Rhodesia. The metal is precipitated at the mine from a zinc solution. The distillation process will be employed at Broken Hill for the production of the refined cadmium.

Corrosion Damage in South Africa.—"The South African Standard Bulletin" states that a reasonable estimate of the cost of corrosion to South Africa is £25 million a year. The journal says that deterioration by corrosion is being allowed to take place in many public and private constructions which cost enormous sums to erect.

An inter-departmental committee is to investigate the problem of rust on the Natal coast where the climate is probably harder on materials and paint than in other parts of the world.

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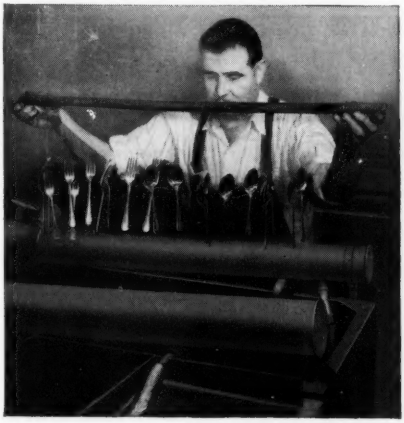

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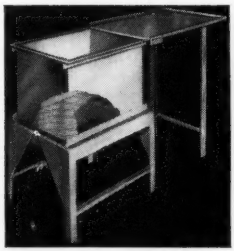

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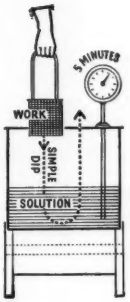

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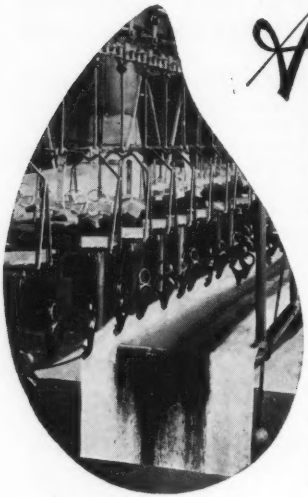

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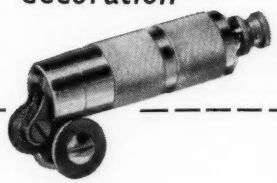

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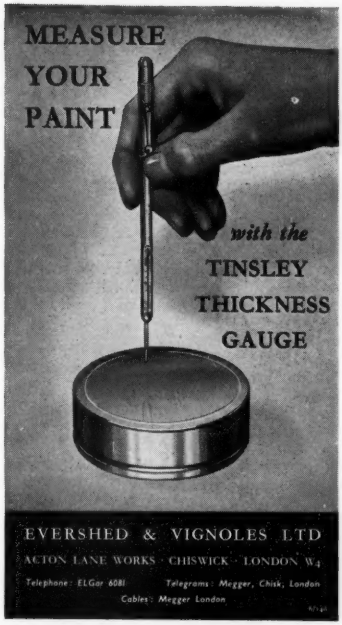

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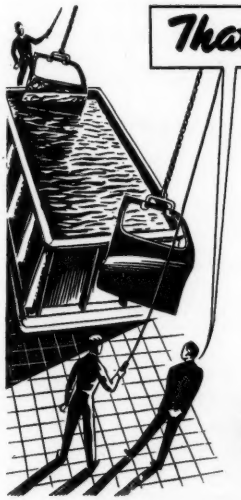

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